EXHIBIT 9

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

ASETEK DANMARK A/S Plaintiff and Counterdefendant, v. COOLIT SYSTEMS, INC., Defendant and Counterclaimant. COOLIT SYSTEMS USA INC., COOLIT SYSTEMS ASIA PACIFIC LIMITED, COOLIT SYSTEMS (SHENZHEN) CO., LTD., Defendants, CORSAIR GAMING, INC. and CORSAIR MEMORY, INC. Defendants.	CASE NO. 3:19-cv-00410-EMC

EXPERT REPORT OF DR. DAVID B. TUCKERMAN REGARDING INVALIDITY OF U.S. PATENT NOS. 8,746,330; 9,603,284; AND 10,274,266

CONTENTS

I. INTRODUCTION

1. My name is David B. Tuckerman. I have been retained as an expert in liquid cooling of electronics, fluid dynamics, thermodynamics, heat transfer, and thermal management of electronic devices by Finnegan, Henderson, Farabow, Garrett & Dunner, LLP for Plaintiff and Counterdefendant Asetek Danmark A/S ("Asetek") in *Asetek Danmark A/S v. CoolIT Systems Inc., et al.*, before the Northern District of California to review and opine on certain claims of U.S. Patent Nos. 8,746,330 ("the '330 patent"); 9,603,284 ("the '284 patent"); and 10,274,266 ("the '266 patent") (collectively "the Asserted CoolIT Patents") and certain representative prior art, and to ascertain the validity of the Asserted CoolIT Patents.[1]

2. This Report sets forth the opinions I have formed in this case and provides the bases and reasons for those opinions. I have created certain exhibits (Exhibits A-C) to be used as a summary of, or as support for, my opinions. The claim charts I-II in Exhibit A, claim charts I-IV in Exhibit B, and the single claim chart in Exhibit C, identify how the prior art correlates with the limitations in each of the asserted claims of the Asserted CoolIT Patents. The charts cite exemplary portions of the prior-art references that disclose particular limitations of the asserted claims, but the citations are informative, not exhaustive. One of ordinary skill in the art would read a prior art reference as a whole and in the context of the state of the art. Therefore, if I am asked to explain my opinions in this Report, I may rely on the uncited portions of the prior art references, other publications or prior art devices, and my general knowledge of the field of the art to explain and aid the understanding of the cited portions of the prior art references, to

[1] My initial expert report on invalidity of CoolIT's patents, served on September 16, 2021, included my invalidity analyses for asserted claims 5 and 25 of U.S. 9,057,567 ("the '567 patent") and asserted claims 1, 5, and 9 of the '266 patent. But because the Patent Trial and Appeal Board (PTAB) found those claims unpatentable, this Report does not include my discussions of those claims. I reserve the right to supplement this Report to include invalidity analyses of claims 5 and 25 of the '567 patent and claims 1, 5, and 9 of the '266 patent if those claims are found not unpatentable following appeal and if they become relevant to this case.

explain the state of the art at the time of CoolIT's alleged inventions, and to establish the motivation to modify or combine cited references.

3. This Report is based on information currently available to me. I understand that I may have an opportunity to supplement my analysis in this Report in response to any reports prepared on behalf of CoolIT. I also understand that I may have an opportunity to amend or supplement my opinions based on further discovery and information provided in this case. Any citation to evidence in this Report is intended to be exemplary, and not intended to be exhaustive.

4. In reaching the opinions set forth herein, I have reviewed and considered the products and materials identified in Exhibit E and all materials identified in my Report, and I have also relied on my experience, education, and expertise. If I am called at trial to provide expert testimony regarding the opinions I have formed resulting from my research and investigation as set forth in this Report, I intend to support or summarize my opinions with prepared appropriate visual aids, and refer to some or all of the documents and information cited in this Report.

5. I am being compensated at the rate of $475 per hour for my work on this case. My compensation does not depend on the outcome of this litigation.

II. SUMMARY OF OPINIONS

6. It is my opinion that the following prior art references anticipate or render obvious each and every element of the asserted claims of the Asserted CoolIT Patents:

   a. US 2006/0096738 to Kang et al. ("Kang")

   b. US 2007/0163750 to Bhatti et al. ("Bhatti")

   c. US 7,259,965 to Chang et al. ("Chang")

   d. US 2007/0125526 to Satou et al. ("Satou")

   e. US 5,998,240 to Hamilton at al. ("Hamilton")

   f. Antarctica "Water Chill" Liquid Cooling Kit ("Antarctica")

7. Specifically, it is my opinion that:

   a. Claims 1, 4, 12, 14, and 15 of the '330 patent are rendered obvious by *Antarctica*, or rendered obvious by *Antarctica* in view of *Chang*;

   b. Claims 3, 5, 15, and 20 of the '284 patent are anticipated by *Bhatti* or rendered obvious by *Bhatti*; anticipated by *Hamilton* or rendered obvious by *Hamilton*; rendered obvious by *Antarctica*; or rendered obvious by *Kang*;

   c. Claims 13 and 15 of the '266 patent are anticipated by *Antarctica*, or rendered obvious by *Antarctica* with or without *Satou*.

8. In addition, claims 3, 5, 15, and 20 of the '284 patent are invalid for lack of written description and/or for indefiniteness.

9. In forming my opinions, I have considered the '330 patent, the '284 patent, and the '266 patent, the Court's claim constructions, analyzed the prior art references and devices listed above, as well as the other materials listed in Exhibit E. My citations to various pictures, drawings, and sections of the written disclosure of the prior art references are illustrative only and in many cases alternative documents, drawings, and pictures further support the described technical features. Further, my description of certain aspects of the prior art with respect to particular claim elements apply equally to other similar claim elements.

III. QUALIFICATION AND EXPERIENCE

10. I have B.S. degrees in Electrical Engineering and Physics, and M.S. in Electrical Engineering and Computer Science from Massachusetts Institute of Technology, Cambridge, Massachusetts. I also have a Ph.D. in Electrical Engineering and a M.B.A. from Stanford University, Stanford, CA. My Ph.D. thesis, titled "Heat-Transfer Microstructures for Integrated Circuits," focused on developing new, high-performance liquid-cooled heat sinks for thermal management of high-speed integrated circuits, and received the Fannie and John Hertz Foundation Hertz Thesis Prize. The key results in my Ph.D. thesis were published in the peer-reviewed journal IEEE Electron Device Letters with the title "High-Performance Heat Sinking for VLSI", and this publication has so far received over 5000 citations in the professional literature, as reported by Google Scholar. This paper was selected by the IEEE Electron Devices Society to receive the first "Paul

Rappaport Award", although this new award series did not get officially approved by IEEE until 1983.

11. I am an experienced innovator and inventor with over 120 issued U.S. patents, many foreign patents, and numerous pending applications, spanning the fields of thermal management systems, heat transfer, electronic packaging and interconnect technologies, and superconducting devices and circuits, etc.

12. I was a member of the Josephson junction computer project (superconducting logic circuit design, simulation, and testing) while attending M.I.T., and worked as a project leader at Lawrence Livermore National Laboratory (LLNL), supervising and managing advanced R&D programs in various fields including electronic packaging and interconnect. My PhD thesis work on microchannel was applied by researchers at LLNL to cool high-power laser diodes; this work was published in the peer-reviewed journal Applied Physics Letters.

13. I founded nCHIP, Inc. in 1989, focusing on advanced multi-chip module technologies enabling ultracompact high-performance digital systems, which was later sold to Flextronics International Ltd. in 1995.

14. I am an experienced entrepreneur, venture capitalist, and executive leader with over 20 years of experience founding, growing and leading technology companies. While working as a senior VP and CTO of Tessera Inc., I helped Tessera grow via various acquisitions, one of which led to the development of a new technology for silent air cooling of laptop computers.

15. I was elected by the IEEE to the grade of "IEEE Fellow", which is the highest membership grade, and for which selection is limited to less than 0.1% of the IEEE membership each year. I was specifically cited "For contributions to high-performance electronic packaging and interconnection technologies, including the development of the microchannel heat sink."

16. I was keynote speaker at the 9th International Conference on Nanochannels, Microchannels, and Minichannels (ICNMM), invited because of my pioneering work in

the field of microchannel cooling. I was also co-author of a review article on Heat Transfer in Microchannels in the peer-reviewed Journal of Heat Transfer.

17. I am a licensed Professional Engineer in California.

18. I am currently an independent consultant through my own company Tuckerman & Associates, Inc., working on various technical and intellectual property matters in the high-tech industries. Some of my major clients have included CMEA Capital, Tessera, Intellectual Ventures, and Microsoft. I have consulted for Microsoft's Quantum Computing and "Cold Logic" programs for 9 years (2011-2020), including management of a 6-year research contract with Auburn University to develop high-density flexible thin-film cryogenic interconnect having optimal heat-transfer properties (i.e., minimal heat leakage between temperature stages) while maintaining excellent electrical performance. I was also a consultant for the first phase of Microsoft's "Project Natick" (which implemented a demonstrative underwater datacenter off the southern California coast in 2015), including the design of the heat exchanger structures and the subsequent analysis of its actual undersea performance.

19. Attached as Exhibit D to this report is a copy of my CV, which provides a detailed listing of my publications and patents, as well as my education and experience. I have not offered any expert testimony in the past 5 years.

IV. RELEVANT LEGAL PRINCIPLES

20. For the purposes of this Report, I have been informed about certain aspects of the law that are relevant to my analysis and opinions. My understanding of these principles is set forth below.

21. I have been informed by counsel and I understand that the first step in determining the validity of a patent claim is for the claim terms to be properly construed. I understand that claim terms are construed in light of the claim language, the patent specification, and the prosecution history of the patent. I also understand that extrinsic sources, for example, dictionaries, treatises, textbooks, etc. may shed light into the meaning of claim terms. I

further understand that a claim term is given its plain and ordinary meaning as understood by those skilled in the art if that claim term does not need construction.

22. I am not an attorney and have not been asked to offer my opinion on the law. However, as an expert offering an opinion on whether certain claims of the Asserted CoolIT Patents are unpatentable, I have been told that I am obliged to follow existing law.

23. I have been told the following legal principles apply to an analysis of invalidity pursuant to 35 U.S.C. § 102, a provision in the patent law regarding anticipation. I have been told that patent claims may be deemed unpatentable if it is shown by clear and convincing evidence that the claims were anticipated by prior art patents, printed publications, or devices. I have also been told that for a claim to be anticipated under § 102, every limitation of the claimed invention must be disclosed by a single piece of prior art, viewed from the perspective of a person of ordinary skill in the art.

24. I have also been told that if the prior art patent, printed publication, or device was available more than one year before the filing date of the patent, then the patentee cannot antedate the prior art by proving earlier invention.

25. I have been told that under 35 U.S.C. § 103(a), "[a] patent may not be obtained although the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains."

26. When considering the issues of obviousness, I have been told that I am to do the following:

a. Determine the scope and content of the prior art;

b. Ascertain the differences between the prior art and the claims at issue;

c. Resolve the level of ordinary skill in the pertinent art; and

d. Consider evidence of secondary indicia of non-obviousness (if available).

27. I have been told that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of alleged invention, which I have assumed is shortly before the effective filing date of each application leading to each of the Asserted CoolIT Patents.

28. I have been told that any assertion of secondary indicia of non-obviousness must be accompanied by a nexus between the merits of the invention and the evidence offered by the patentee.

29. I have been told that a reference may be combined with other references to disclose each element of the invention under § 103. I have been told that a reference may also be combined with the knowledge of a person of ordinary skill in the art and that this knowledge may be used to combine multiple references. I have also been told that a person of ordinary skill in the art is presumed to know the relevant prior art. I have been told that the obviousness analysis may account for the inferences and creative steps that a person of ordinary skill in the art would employ.

30. I have been told that whether a prior art renders a patent claim obvious is determined from the perspective of a person of ordinary skill in the art. I have been told that there is no requirement that the prior art contain an express teaching or suggestion to combine known elements to achieve the claimed invention, but that a motivation or rationale for combining prior art elements in a way that realizes the claimed invention is required to show obviousness, and that it seeks to counter impermissible hindsight analysis.

31. I have been told that when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. I have been told that if a person of ordinary skill in the art can implement a predictable variation and would see the benefit of doing so, that variation is likely to be obvious. I have been told that, when there is a design need or market pressure and there are a finite number of predictable solutions, a person of ordinary skill in the art has good reason to pursue those known options that realizes the claimed invention. In addition, I have been informed and I understand that there must be a reasonable expectation of success—not absolute

predictability of success—in combining prior art teachings to arrive at the claimed invention.

31. I further understand that, to be valid, the patent must contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains to make and use it. It is my understanding that this involves two separate requirements. First, the patent must describe the asserted invention in such a way as to reasonably convey to one of ordinary skill in the art that the named inventor(s) had possession of the claimed invention at the time of the application. I understand that this is referred to as the "written description" requirement. Second, the patent must describe how to make and use the full scope of the asserted invention without undue experimentation. I understand that this is referred to as the "enablement" requirement.

32. I understand that the written description, drawings, and claims in the patent must clearly allow a person of ordinary skill in the art to understand and recognize that the named inventor(s) invented what is claimed. The disclosure of the application relied upon must reasonably convey to those skilled in the art that the inventor(s) had possession of the claimed subject matter as of the filing date. Actual possession or reduction to practice outside of the specification is not enough. The specification itself must demonstrate possession. A description that merely renders the invention obvious to one of ordinary skill in the art does not satisfy the written description requirement.

33. I also understand that the enablement requirement is met only when a person of ordinary skill in the art, after reading the specification, could practice the invention in the asserted claims without undue experimentation. I have been advised that the full scope of the asserted invention must be enabled. I understand that I should consider several factors in determining whether the level of disclosure in the patent would require undue experimentation and show a lack of enablement, including: (1) the quantity of experimentation; (2) the amount of direction or guidance present; (3) the presence or absence of working examples; (4) the nature of the invention; (5) the state of the prior

art; (6) the relative skill of those in the art; (7) the predictability or unpredictability of the art; and (8) the breadth of the claims.

34. Finally, I understand that for a patent to be valid, the patent claims must particularly point out and distinctly claim the subject matter the applicant regards as his invention. Therefore, one of ordinary skill in the art to which the patent pertains must be able to determine the scope of the invention with reasonable certainty by analyzing the claims in view of the patent specification and the patent file history.

V. RELEVANT CLAIM CONSTRUCTIONS

32. I understand that Asetek and CoolIT stipulated that the term "microchannels" appearing in various claims of the Asserted CoolIT Patents means "channels with widths up to 1 millimeter."

33. I understand that the following terms of the Asserted CoolIT Patents have been construed by the Court as follows:

a. "fluid heat exchanger": "component that transfers heat from a heat source to a cooling liquid circulated by a pump that is external to the component"

b. "inlet header": "a space out from which the liquid to be distributed flows"

c. "outlet header": "a space into which the collected liquid flows"

d. "adjacent" and "juxtaposed with": "with no intervening solid structure between it and"

e. "seal": "a component that fills a gap to prevent leakage through the gap"

34. I further understand that the Court has declined to construe the terms "inlet," "inlet opening," "aperture," "outlet opening," "inlet/outlet flow path," "first/second side of the [plurality of] fins," and "first/second side of the plurality of juxtaposed fins" appearing in various claims of the Asserted CoolIT Patents, and found that these claim terms should be given their plain and ordinary meaning.

35. I have applied the parties' agreed constructions and the Court's constructions in my analyses. For the claim terms that were given plain and ordinary meaning by the Court, I

have explained how a person skilled in the art will understand those terms in the context of liquid cooling technology.

VI. PERSON OF ORDINARY SKILL IN THE ART

36. A person of ordinary skill in the field of computer liquid cooling at the time of the effective filing dates of the Asserted CoolIT Patents was someone who has completed college level course work in thermodynamics, fluid mechanics, and heat transfer, and would have two or more years of experience in designing liquid cooling systems for computers, servers, or other electronic devices, or very similar technology. Alternatively, a person of ordinary skill in the art could have been a person with a more advanced degree in the above fields but less practical experience.

37. I believe that I have the relevant experience and understanding of one of ordinary skill in this field.

VII. THE CORE CONCEPT OF THE ALLEGED INVENTION OF THE ASSERTED COOLIT PATENTS WAS WELL KNOWN

38. The Asserted CoolIT Patents are directed to a fluid heat exchanger for cooling of heat-generating electronic devices. CoolIT's claimed fluid heat exchanger is designed to be placed on top of a heat-generating electronic component (e.g., a processor) and to transfer heat from the electronic component to a liquid coolant[2] flowing through microchannels on a cold plate (aka a heat-exchanging interface or a heat spreader plate) of the fluid heat exchanger.

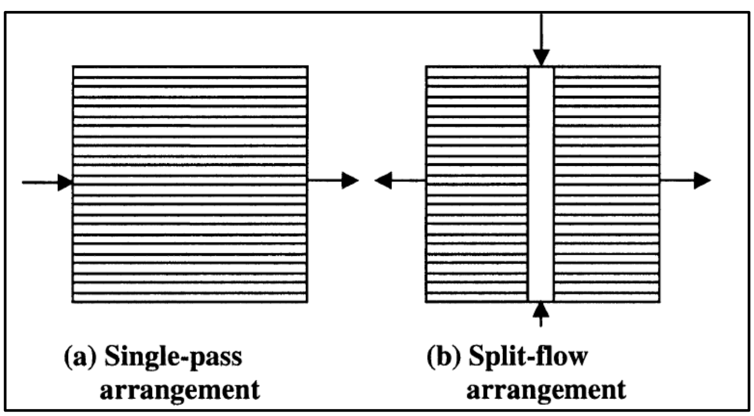
39. The crux of CoolIT's disclosed and claimed fluid heat exchanger is an arrangement that allows the coolant to enter the microchannels at about midway along their length, such that the flow of coolant splits into two sub-flows that proceed in opposite directions towards the end of the microchannels. Such a flow arrangement is known in the field of

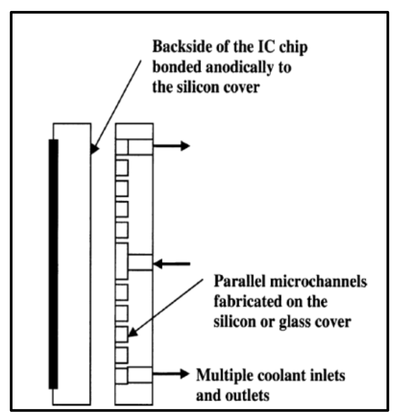
[2] In this Report, I have used the terms "coolant," "cooling fluid," "cooling liquid," and "heat-transfer fluid" interchangeably to mean a liquid medium used to remove heat from the fluid heat exchanger.

liquid cooling as split-flow. But such split-flow arrangements in microchannels were routinely used before CoolIT filed its patents.

40. Split-flow arrangements in microchannels were well known before 2007, and were understood to reduce fluid pressure drop and flow resistance through the microchannels, and to reduce the maximum temperature of the electronic component being cooled. This is because when coolant enters each channel at midway along its length and splits into two sub-flows in a split flow arrangement, each sub-flow then has to travel along only half of the channel's length, instead of coolant having to travel through the full length of each channel from one end of the channel to the other as in a side-to-side/single pass arrangement. Each sub-flow also accumulates half as much heat from the electronic component as would a single-pass flow, and furthermore can transfer heat more efficiently due to the thermal boundary layer being thinner (i.e., less fully developed) than would be the case for a full-length channel. In short, split-flow was known before 2007 to minimize pressure drop and flow resistance through microchannels and improve overall cooling of electronic components for these reasons.

41. For instance, a 2005 engineering publication by *Kandlikar* compares split-flow with single-pass flow and includes the figures reproduced below:





Kandlikar, pp. 7, 9 (showing split flow in microchannels)

42. *Kandlikar* discussed that "[t]he split flow arrangement shown [above] can be further extended to provide multiple inlets and outlets as originally recommended by Tuckerman

and Pease []. Reducing the flow length through the channel passages results in the lowering of the pressure drop. Another advantage of the split-flow arrangement is seen in the increased heat transfer coefficient near the multiple channel entrance regions due to entrance effects (thermally developing flow)." *Id.* at pp. 9-10.

43. The Tuckerman and Pease article referred to by Kandlikar is an article I authored based on research that I had conducted for my Ph.D. thesis at Stanford. My Ph.D. thesis, which was published in February 1984, was provided at ASE-CLT00051490 – ASE-CLT00051649 (hereinafter "Tuckerman Ph.D. Thesis"). As discussed in pages 47-48 of my thesis, I described heat-transfer improvements in microchannels using split-flow in this 1984 publication (and the relevant work leading to my thesis was done as early as 1981). As discussed in my thesis, heat transfer from a surface can be increased by scaling down the microchannel length, which can be achieved by having multiple coolant inlet and outlet points along the cold plate as shown in the figure, below, and thereby creating multiple split-flows throughout the length of the cold plate.

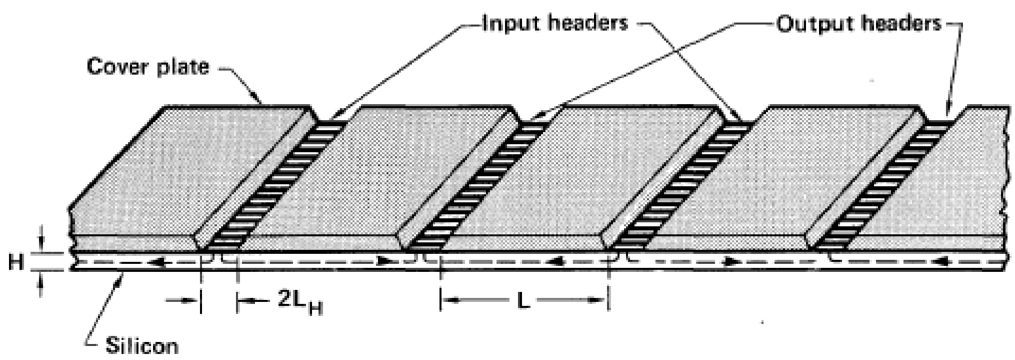


Figure 2-10: A multiple-header arrangement to allow scaling down of the channel length L. The header width L_H should be comparable to the silicon thickness H for proper heat transfer over the header regions.

Tuckerman Ph.D. Thesis, p. 47.

44. Patents covering split-flow arrangements in microchannel-based heat sinks were also filed and granted long before CoolIT filed its patents. For instance, U.S. Patent No. 5,099,311 to Bonde et al. (ASE-CLT00044406-19, "Bonde"), which issued in March 1992, discloses split-flow arrangement in microchannels as shown below:

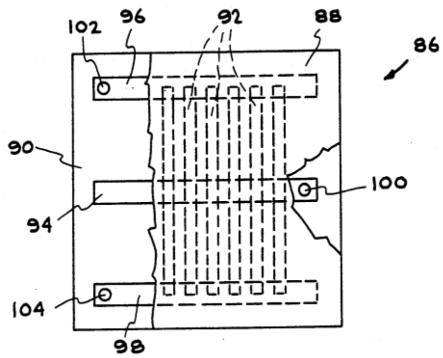


FIG. 6

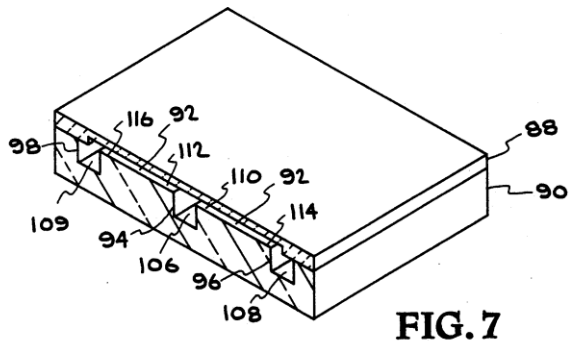


FIG. 7

Bonde, Figs. 6, 7; *see also Bonde*, Title, Abstract and 6:62-7:43 (discussing microchannel heat sink configuration).

45. Moreover, the above-described publications and figures demonstrate that it was well-known before August 2007 that positioning the coolant inlet at the central region of the cold plate (of the fluid heat exchanger), as in the split-flow configuration disclosed in the Asserted CoolIT Patents, allows the coolant to make thermal contact with the center of the cold plate first, before collecting any heat from the perimeter of the fluid heat exchanger. This arrangement was known to be important for heat-removal efficiency because the center of the cold plate is generally positioned right above the heat-generating processing unit and is therefore hotter than the peripheries of the cold plate. The asserted Asetek patents in this case (which have effective filing dates before August 2007), for instance, disclose cooling liquid entering at the center of the thermal exchange chamber and exiting at the periphery of the chamber. *See* Figure 9 of Asetek Patent Nos. 8,240,362; 10,613,601; and 10,599,196. Allowing coolant to enter at the center of the cold plate (as opposed to the sides as in a side-to-side flow) ensures more efficient heat removal from the hottest and the most critical region of the fluid heat exchanger.

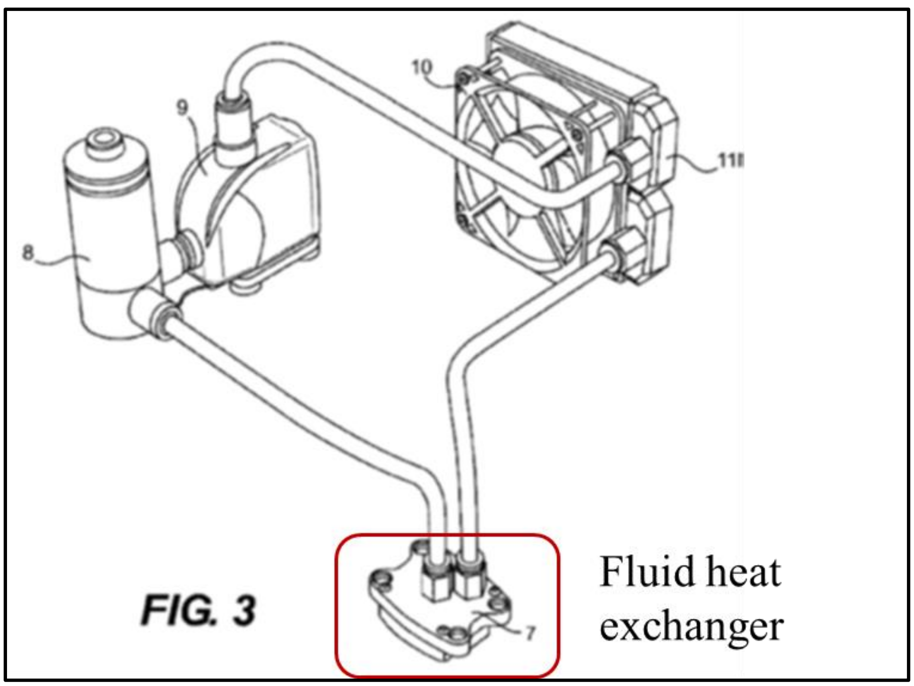
46. The above prior-art references are examples that demonstrate that split-flow in microchannels was well-known in the art prior to CoolIT's alleged invention. Below, I also discuss many additional prior-art references that also describe split-flow configurations and their associated functions and benefits. Commercial products, such the

Danger Den-RBX and the *Antarctica* (developed and marketed by Asetek) are examples of prior art devices that utilize split-flow to improve thermal efficiency.

VIII. THE ASSERTED CLAIMS OF THE '330 PATENT ARE INVALID

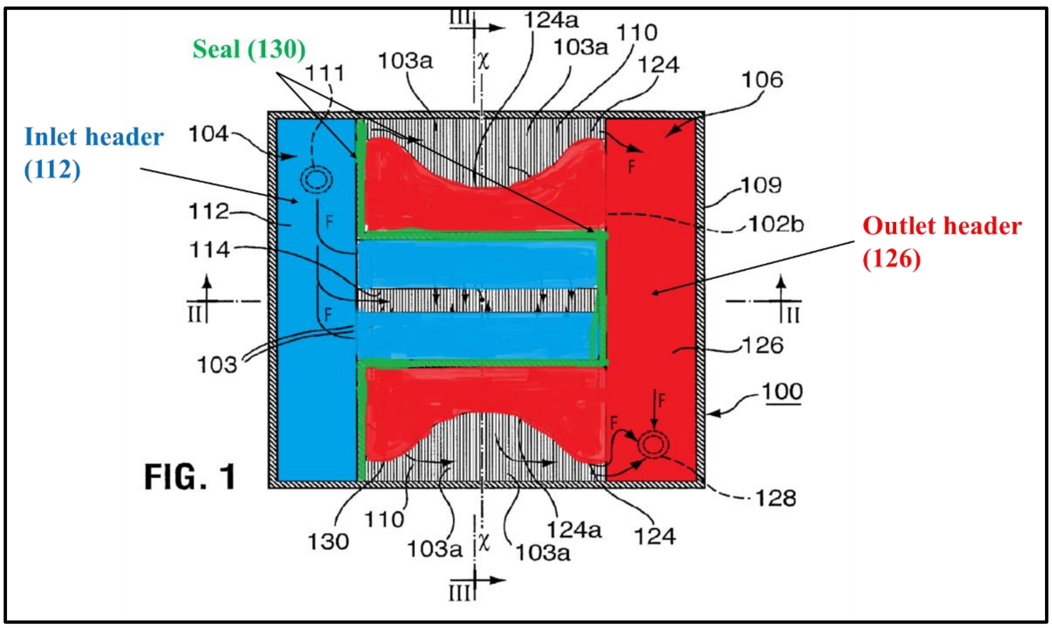
A. BACKGROUND TECHNOLOGY OF THE '330 PATENT

47. The '330 patent describes a fluid heat exchanger for liquid cooling of electronic devices, e.g., a computer system. In terms of the prior art Figure 3 of the Asetek patents, illustrated below, CoolIT's alleged invention is essentially directed to heat exchanger 7 (in Figure 3 of the Asetek patents), which is connected in a closed loop to a prior art liquid reservoir, a prior art pump, and a prior art heat radiator. In fact, the claimed "fluid heat exchanger," to which all of the '330 patent claims are directed, was specifically construed by the Court to mean "component that transfers heat from a heat source to a cooling liquid circulated by *a pump that is external to the component*." That is, CoolIT's claimed fluid heat exchanger is separate and distinct from a pump that drives cooling liquid through the fluid heat exchanger to collect heat from an electronic device placed in thermal contact with the fluid heat exchanger.



The Asetek Patents, Fig. 3

48. The '330 patent describes a very specific structure/arrangement for a fluid heat exchanger 100 for cooling electronic devices. The fluid heat exchanger 100 includes 1) a heat spreader plate (cold plate) 102 having fins/walls 110 extending therefrom and defining microchannels 103 between adjacent walls; 2) a manifold plate sitting on top of the walls 110 to close off the microchannels; and 3) a housing 109 having a recessed underside. '330 patent, 2:42-48, Figs. 1-3. The heat spreader 102 and the housing 109 together form the outer limits of the heat exchanger 100. *Id.* The housing 109 defines an inlet passage 104 and outlet passage 106, including an inlet header 112 and an outlet header 126, respectively. *Id*. at 3:66-4:3, 5:1-11. The inlet header is shown in blue and the outlet header is shown in red in Figure 1 annotated below. The housing 109 also includes inlet port 111 and outlet port 128 that lead to and from the inlet and outlet headers. *Id.*

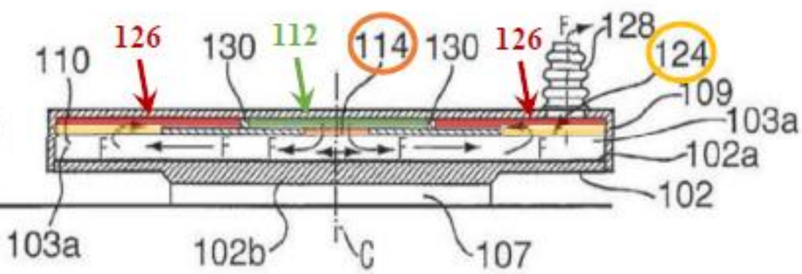


'330 patent, Fig. 1 (annotations added).

49. The inlet and outlet headers are separate and distinct from inlet opening 114 and outlet openings 124. Although any space/volume above the inlet and outlet openings 114 and 124 may be considered part of the headers 112 and 126, the headers do not include the inlet and outlet openings 114 and 124. *See* '330 patent, 3:66-4:3, 5:1-11. CoolIT agrees

that the inlet opening 114 and outlet openings 124 are not part of the headers. For example, in CoolIT's reply claim construction brief (Dkt. 115), CoolIT argued that the volume *above* the inlet 114 and the plate (shown in green in annotated Figure 3, below) is part of the inlet header 112 and the volumes above outlets 124 and the plate (shown in red in annotated Figure 3, below) are part of the outlet headers 126. Dkt. 115 at 11.

FIG. 3



Dkt. 115 at 11

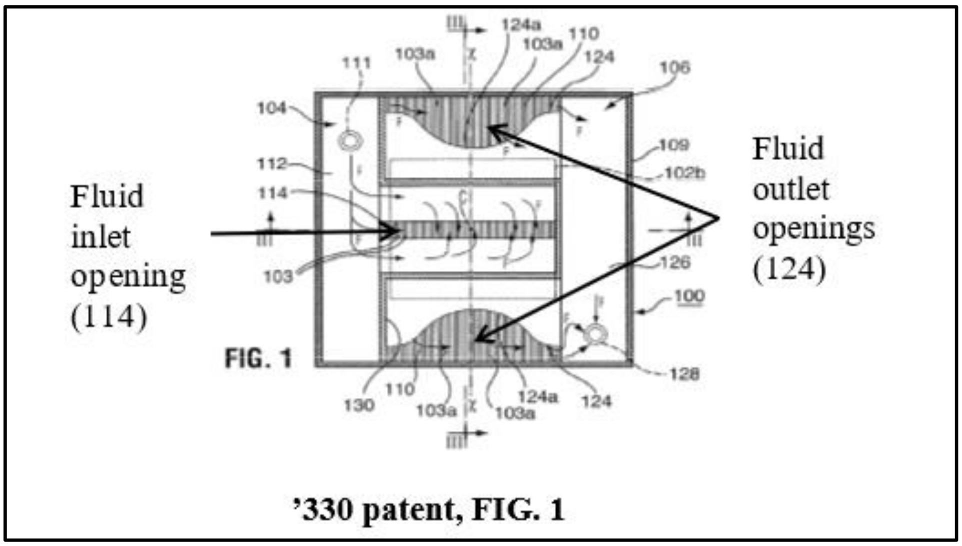
50. Specifically, CoolIT argued with reference to the annotated Figure 3 shown above that:

> [T]he inlet header 112 (green) is above the plate and the inlet opening 114 (orange), while the outlet header 126 (red) is above the plate and the outlet openings 124 (gold). The depictions above are consistent with the testimony of CoolIT's expert explaining that the "[o]pening 114 is the bottom surface of the inlet header[112, which] is a volume …, and at the bottom of this volume … is the plane that defines the inlet opening [114]." The depictions above are also consistent with CoolIT's statements made during prosecution: "some disclosed heat exchangers have opposed outlet headers (or portions thereof) extending over the fins *and over the plate*, and that some disclosed heat exchangers have an inlet header (or a portion thereof) positioned between the opposed outlet headers.

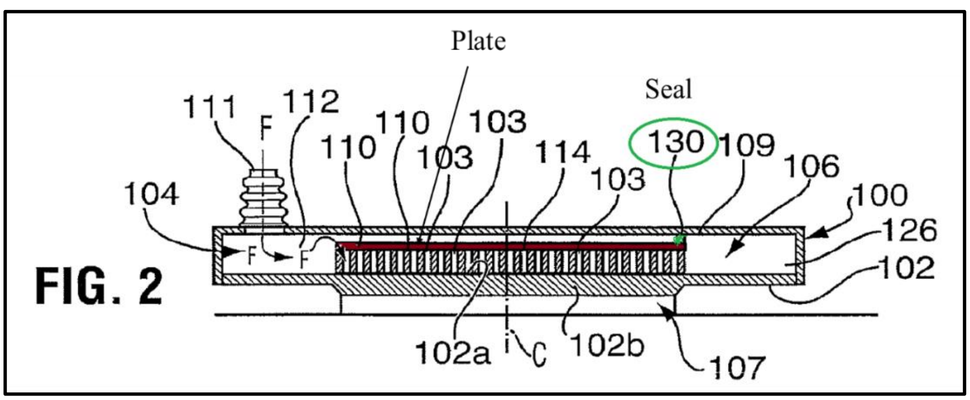
Dkt. 115 at 11 (internal citations and quotations omitted). That is, CoolIT explicitly excluded inlet 114 and outlets 124 from headers 112 and 126. *See id.*

51. The plate on top of walls 110 (shown in dark brown in Figure 2, annotated below) is positioned inside the heat exchanger housing 109, where it is pressed against the tops of the microchannel walls 110 and the underside of housing 109 by a seal 130 (shown in green in Figure 1 annotated above and Figure 2 annotated below) to prevent coolant bypass between the inlet and outlet sides of the heat exchanger. '330 patent, Figs. 1-3;

6:52-55. The plate includes cut-outs that form an elongate inlet opening 114 and two outlet openings 124 flanking the inlet opening 114. *Id*. at 3:66-4:14, 5:1-31; Figs. 1-3. The inlet opening 114 runs transverse to the length of the microchannels. *See id.* Fig. 1. The manifold plate is positioned on the microchannels so that the elongate opening sits approximately midway along the length of the microchannels, as shown in Figure 1. *Id.* at 5:44-6:35. This creates a split-flow arrangement in which cooling liquid enters the microchannels at their mid-point through inlet opening 114, splits into two sub-flows and proceeds outwardly towards the pair of outlet openings 124 formed by cut-outs in the manifold plate where the fluid exits the microchannels. *See id*. From outlets 124, heated liquid collects in outlet header 126, and from there the heated liquid is conveyed out of the fluid heat exchanger through outlet port 128. *Id*. at 6:32-35.

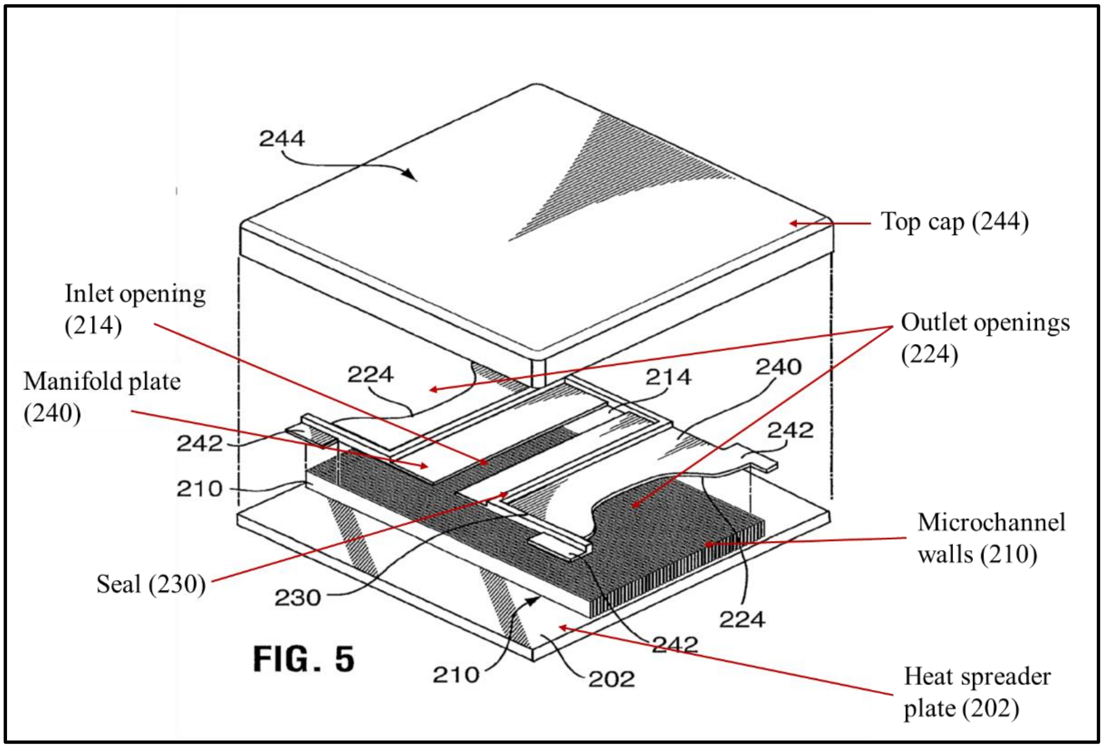


’330 patent, Fig. 1 (annotations added).



’330 patent, Fig. 2 (annotations added).

52. Figures 4 and 5 illustrate a method of manufacturing fluid heat exchanger 100. A housing having a top cap 244 is placed over the heat spreader plate 202 and manifold plate 240 to form the heat exchanger, as shown in Figure 5 of the '330 patent (annotated below). '330 patent, 6:56-7:16. A seal 230 is provided between the manifold plate 240 and the underside of cap 244 to separate the inlet and the outlet sides of the fluid heat exchanger, to force liquid to flow from inlet opening 214 to outlet openings 224 through the channels defined between walls 210. *Id.* Seal 230 may be fused to the underside of cap 244 to prevent short circuiting of liquid from the inlet to the outlet side. *See id.*



'330 patent, Fig. 5 (annotations added).

53. I have been advised to use August 9, 2007 as the earliest priority date for the purposes of my analysis of the '330 patent, and to assume that the timeframe for the alleged invention of the '330 patent is on or around August 9, 2007.

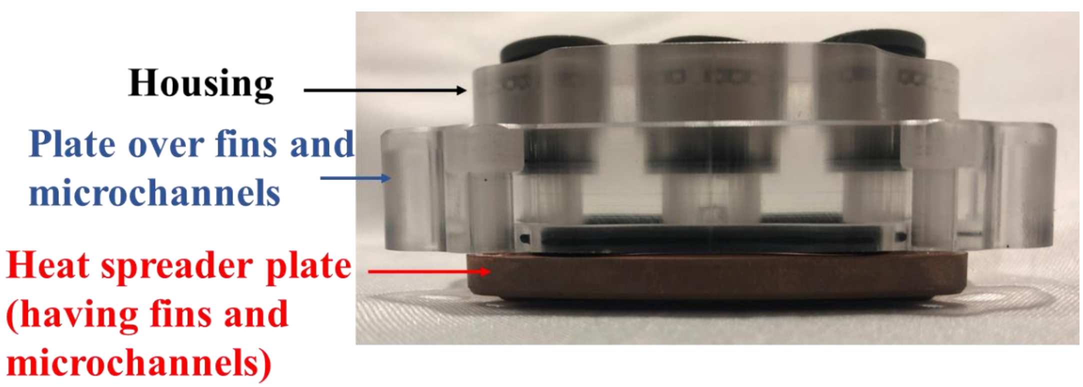
B. SUMMARY OF PRIOR ART THAT RENDERS THE ASSERTED CLAIMS OF THE '330 PATENT INVALID

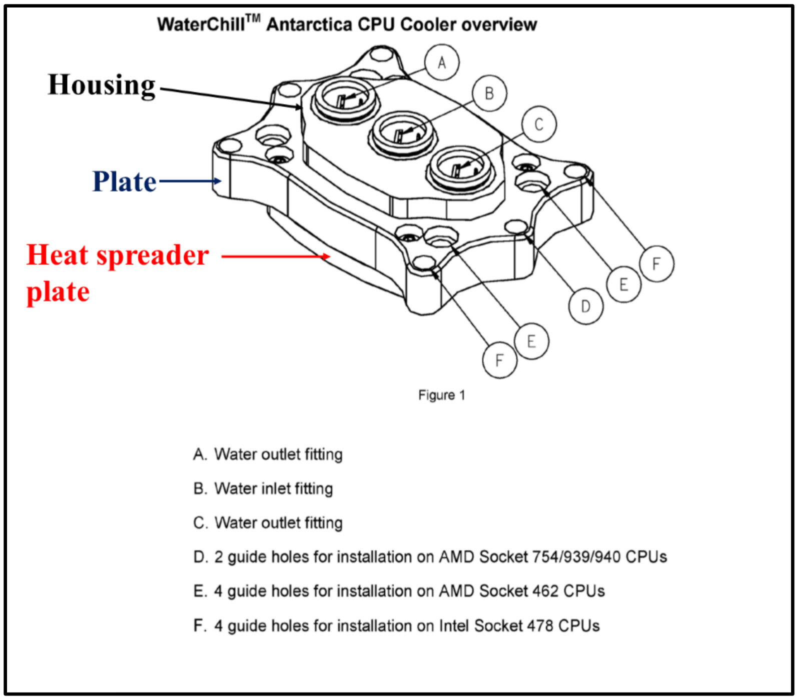
Antarctica

54. It is my understanding that Asetek invented and sold the Antarctica WaterChill™ CPU Cooler ("*Antarctica*") in the U.S. in 2004, i.e., prior to the August 9, 2007 priority date of the '330 patent. Therefore, *Antarctica* is prior art to the '330 patent.

55. The *Antarctica* is a fluid heat exchanger that is connected to a prior art pump, a prior art reservoir, and a prior art radiator in a closed loop using ½ inch and 10 mm hoses, as shown in Figure 3 of the Asetek patents. ASE-CLT00045006, ASE-CLT00045013.

56. The *Antarctica* has three significant components — a heat spreader plate (aka cold plate) having a plurality of microchannels, a plate positioned over the microchannels, and a housing.

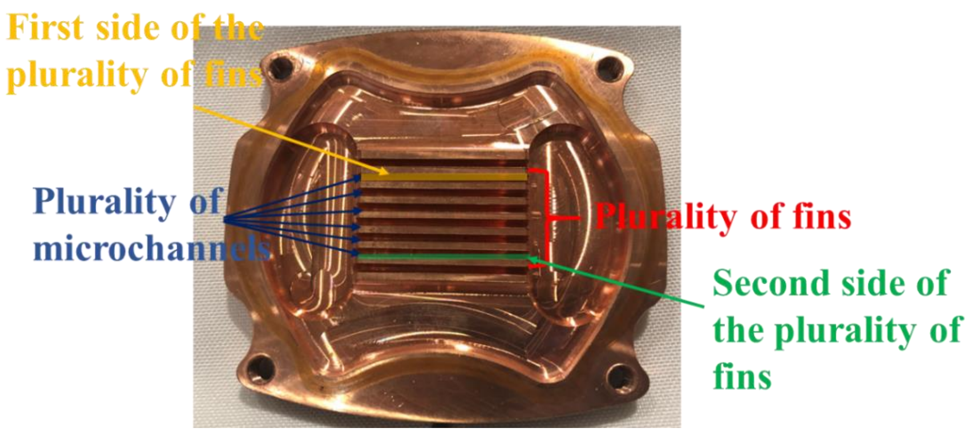




ASE-CLT00045007

57. The heat spreader plate of the *Antarctica* includes a plurality of fins defining a corresponding plurality of channels therebetween, as shown below. The space between adjacent fins is about 0.9 - 1.0 mm, and therefore the channels formed between adjacent fins are microchannels per the parties' stipulation that "microchannels" means "channels with widths up to 1 millimeter." *See also* Andre Dep. Tr. at 117:17-25 (Mr. Eriksen who designed and developed the Antarctica waterblock testifying that the width of the channels in the Antarctica is "between 0.6 and 0.8 millimeters."). In fact, the '330 patent itself teaches that the "microchannel walls 110 [i.e., the fins] may be spaced apart by a separation dimension range of 20 microns to 1 millimeter[.]" '330 patent, 3:56-60. Moreover, a person of ordinary skill in the art in August 2007 would have known that the fins in a fluid heat exchanger should be disposed in such a way that they would form microchannels between adjacent fins. This is because it was well-known by August 2007 that microchannels have large surface area-to-volume ratio, and therefore, microchannels provide a large heat transfer surface area per unit fluid flow volume as compared to macrochannels or minichannels. Accordingly, a person of ordinary skill in the art would

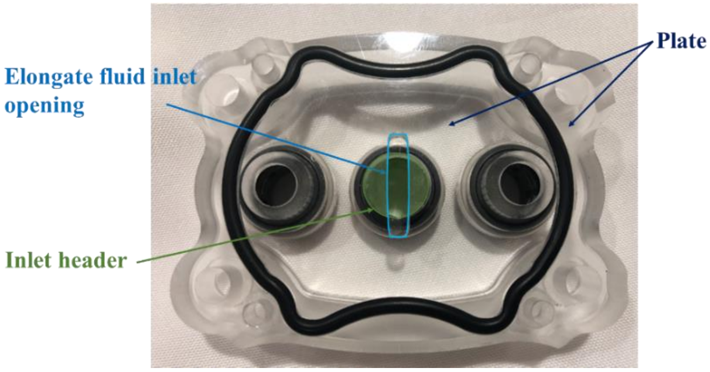
readily form microchannels (in place of macro- or mini-channels) on a heat transfer surface of a fluid heat exchanger to enhance thermal transfer.

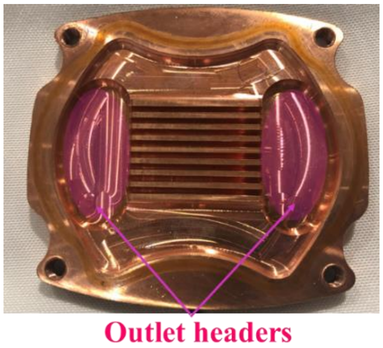


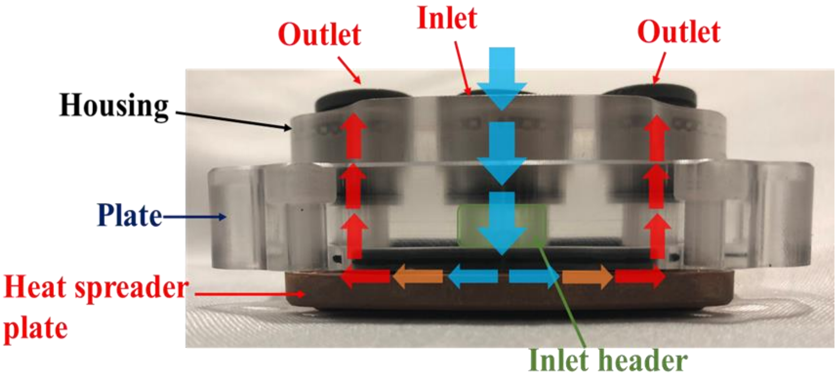
58. The Court has decided that "a 'plurality of fins' need not include *all* fins on the heat spreader plate," that the term "'plurality of fins' has a plain and ordinary meaning to a person of ordinary skill in the art ('POSITA')," and further that "[b]oth sides' experts agree that a POSITA would understand the term 'plurality of fins' or 'plurality of juxtaposed fins' to mean 'more than one fin'/'more than one juxtaposed fin.'" Dkt. 258 at 7, 11 (emphasis in original). Accordingly, I have interpreted a subset of the fins (7 out of the 9 fins) on the heat spreader plate of the *Antarctica* as constituting the "plurality of fins," as shown above. The inner sides of the outermost fins in the "plurality of fins" are adjacent to the inlet/outlet headers, as discussed in Chart I of Exhibit A.

59. The housing of the *Antarctica* fluid heat exchanger defines an inlet and dual outlets. The inlet opens into an inlet header, from where cooling fluid flows into the microchannels through an elongate fluid inlet opening defined on the manifold plate over the microchannels. Cooling fluid splits into two sub-flows within the microchannels, and each sub-flow proceeds outwardly towards the microchannel ends. Fluid exits the microchannels through openings at the ends of the microchannels and enters respective

outlet headers, and from there the fluid exits the fluid heat exchanger through the outlets in the housing.







Chang

60. *Chang* was filed on April 7, 2005, i.e., before the August 9, 2007 priority date of the '330 patent. Therefore, *Chang* is prior art to the '330 patent.

61. *Chang* discloses a fluid heat exchanger, referred to as a microchannel assembly, for removing heat from heat-generating electronic components, e.g., integrated circuit chips. Specifically, *Chang* discloses a microchannel assembly 404, which is thermally coupled to an IC 402 to form an integrated system. *Chang*, 4:56-61.

62. Another embodiment of a microchannel assembly 1102 is depicted in Figures 11 and 13. *Chang* teaches that the features of the two embodiments — the microchannel assembly 404 having single-pass flow and the microchannel assembly 1102 having split-flow arrangement —may be combined. *Id.* at 9:55-60. For example, the right-angle style of inlet/outlet passages shown in the single-pass the manifold plate 446 shown in Figure 4 may be integrated with the split flow inlet/outlet arrangement shown in Figures 11 and 13. *See id.* Accordingly, *Chang* teaches a microchannel assembly 1102 ("fluid heat exchanger") having a **manifold plate 446** ("housing"), a **cover plate/lid 410 or 1406** ("plate" over the microchannels/fins), and a **microchannel structure 408 or 1402** ("heat spreader plate") having a plurality of fins and microchannels, as shown below. *Id.* at Figs. 4, 11, 13, 14. The manifold plate 406 ("housing") includes **inlet passage 426** and **outlet passage 436**. *Id.* at Fig. 4. A **sealant 418** extends between the **manifold plate 446** ("housing") and the **cover plate/lid 410 or 1406** ("plate"). *Id.* at 5:14-55. A person skilled in the art will understand that sealant 418 is provided to prevent fluid leakage or bypass between the inlet and the outlet and force fluid to flow through the microchannels, and also to prevent leakage to the outside.

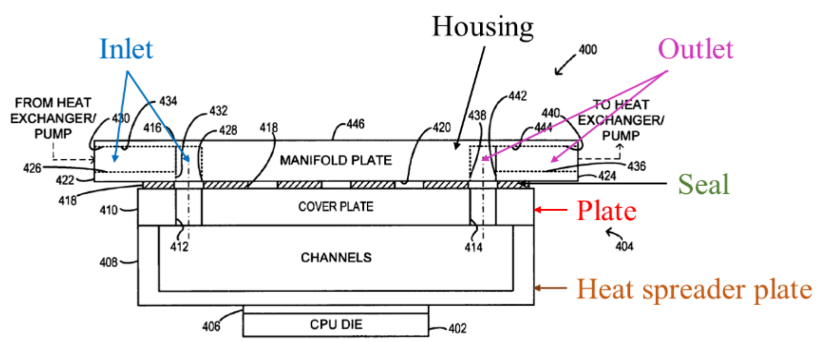
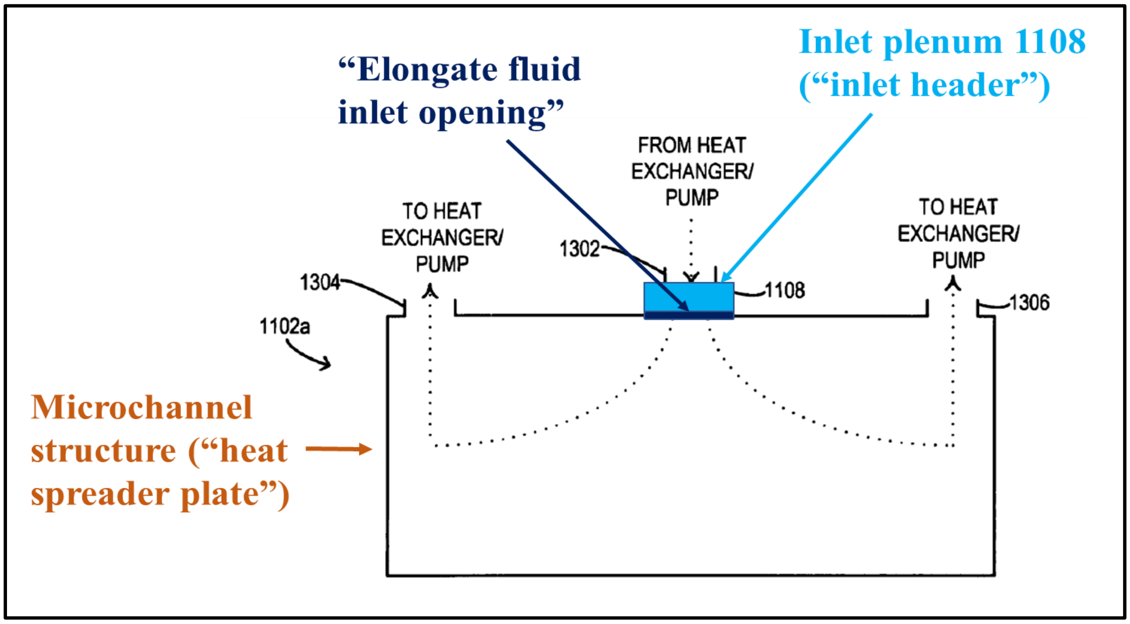


FIG. 4

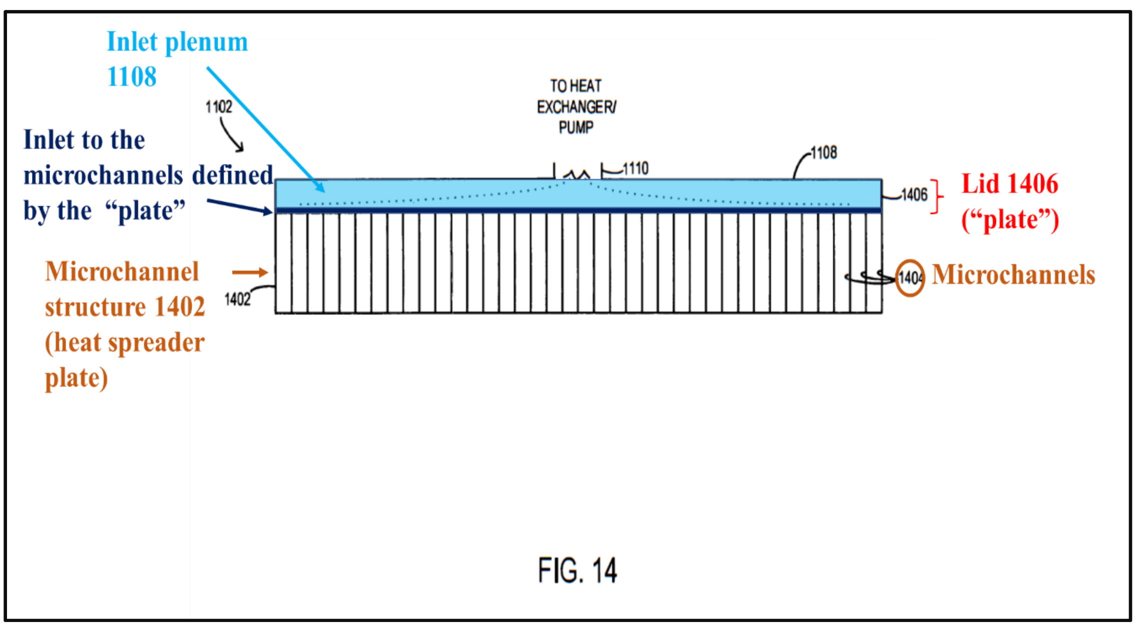
Chang, Fig. 4 (showing microchannel assembly 404)

63. The microchannel assembly 1102 ("fluid heat exchanger") has an **inlet plenum 1108**, which serves as an "inlet header." Cooling fluid from the inlet passage of the "housing"

flows through an opening 1110/1302 at the top surface of **cover plate/lid 1406** ("plate") and collects in the **inlet plenum 1108** ("inlet header"). *Chang*, 9:6-54, Figs. 11, 13, 14. From the "inlet header," cooling liquid passes through an **elongate fluid inlet opening** defined by the bottom surface of the **cover plate/lid 1406** ("plate") and into the **microchannels 1404**. *See id.*



Chang, Fig. 13 (showing microchannel assembly 1102; annotation added)



Chang, Fig. 14 (showing microchannel assembly 1102; annotations added)

64. After flowing through the microchannels, cooling fluid exits the microchannels through openings at the end of the microchannels and collects in **reservoirs 1112** ("outlet headers") at the ends of the microchannels, then fluid flows through openings 1104/1304 and 1106/1306 in **cover plate/lid 1406** ("plate"), and finally the cooling fluid flows out through the outlet passages in the "housing." *Id.* at 9:24-36, 46-54, Figs. 11 and 13.

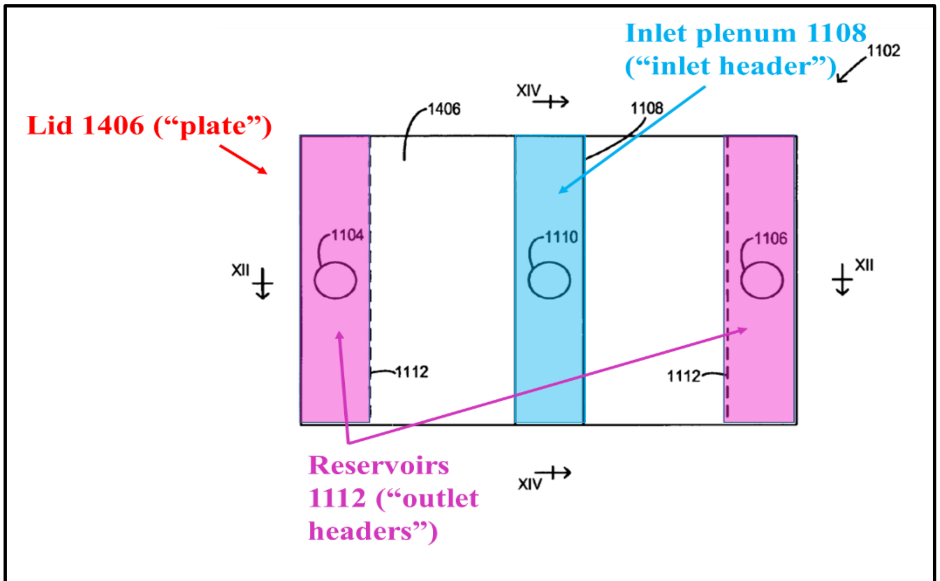


FIG. 11

Chang, Fig. 11 (showing microchannel assembly 1102)

C. THE *ANTARCTICA* DEVICE RENDERS THE ASSERTED CLAIMS OF THE '330 PATENT OBVIOUS

65. The claim chart I in Exhibit A illustrates how the *Antarctica* correlates with the limitations in independent claims 1, 12, and 14 and dependent claims 4 and 15. In my opinion, the *Antarctica* prior art device disclose each and every limitation of the asserted claims except a "seal" (i.e., "a component that fills a gap to prevent leakage through the gap" per the Court's construction) between the housing and the plate. This is because the housing and the plate of the *Antarctica* fluid heat exchanger comprise a continuous/monolithic structure, so a separate gasket or O-ring between the housing and the plate are not needed to create a fluid-tight contact between them.

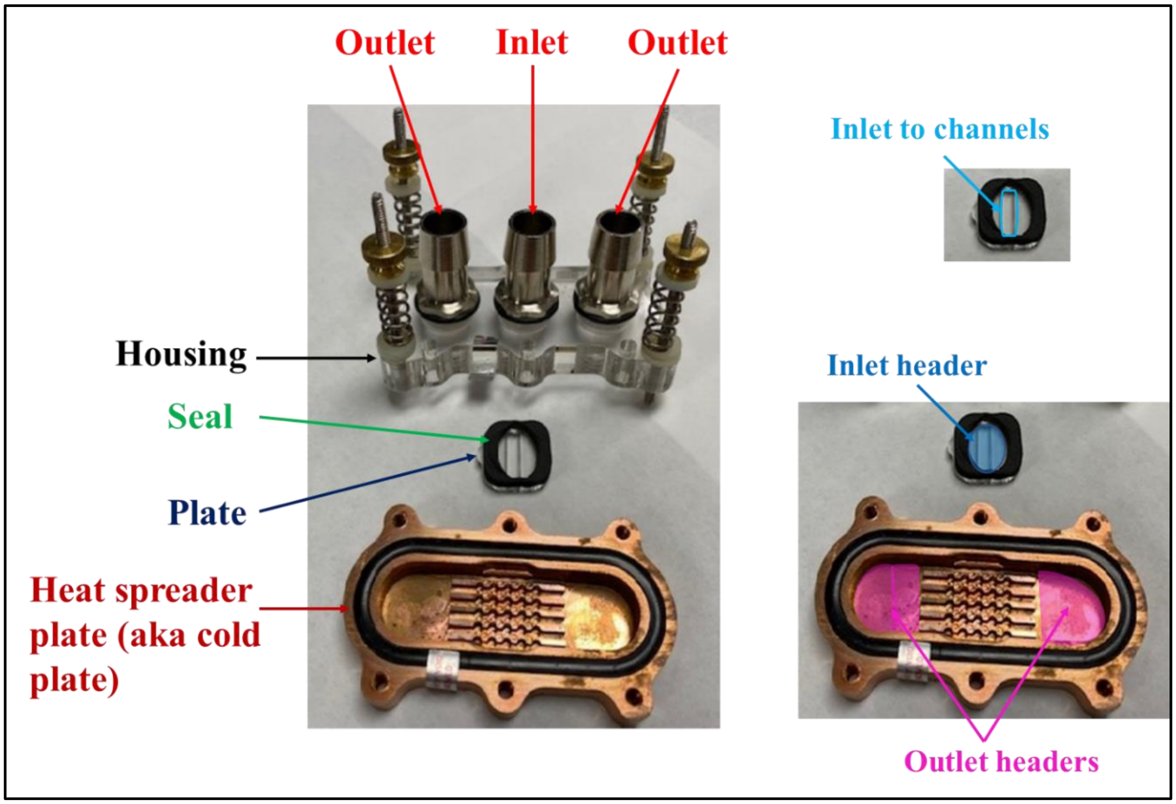
66. But having the housing and the plate as separate components that are sealed would have been an obvious modification of the *Antarctica* prior art device. This is because the single-piece housing and plate of *Antarctica* was precision CNC (Computer Numerical Controlled) machined, which is an expensive and complex manufacturing technique for small-batch products. But to manufacture *Antarctica* products in large batches (at scale), it would have been obvious and desirable to make the housing and plate separately and then assemble the units with a seal between them, which would simplify volume manufacturing of the fluid heat exchanger and allow for better manufacturing scalability. Making the housing and the plate separately would also allow the housing and the plate to made of different materials — for example, the plate might be made of a stamped metal sheet that bonds, solders, or seals best with the tops of the microchannel fins, and the bulkier housing (which has the inlets and the outlets) could be made of a cost-effective material such as plastic, thus reducing overall manufacturing costs. These manufacturing advantages of separating the housing and the plate are specifically taught by *Chang*, as further discussed below. *See Chang*, 5:5-19, 6:13-19. Another advantage of separating the housing and plate is that if there were a change in the processor configuration (and a resulting change in the heat spreader plate configuration), then only the plate configuration would have to be revised to correspond to the changes in the heat spreader plate; the housing configuration could remain unchanged and only the old plate would need to be swapped out for a new plate. *See also id.* at 6:22-30. Given the manufacturing and cost advantages of having separate housing and plate, a person skilled in the art in August 2007 would have been motivated to modify the *Antarctica* fluid heat exchanger to have separate parts/components forming the housing and the plate as shown in Figures 1-5 of the '330 patent. Such a modification of the *Antarctica* would have only involved rearrangement/reconfiguration of prior art elements according to known methods to obtain predictable results, and as such a person skilled in the art would have reasonably expected success in such a modification.

67. In fact, whether the housing and the plate are continuous (as in the *Antarctica*) or are separate structures that are connected together (as in Figures 1-5 of the '330 patent) is a matter of design choice because the results and functions of the fluid heat exchanger — regardless of whether the housing and the plate are continuous, or formed of separate

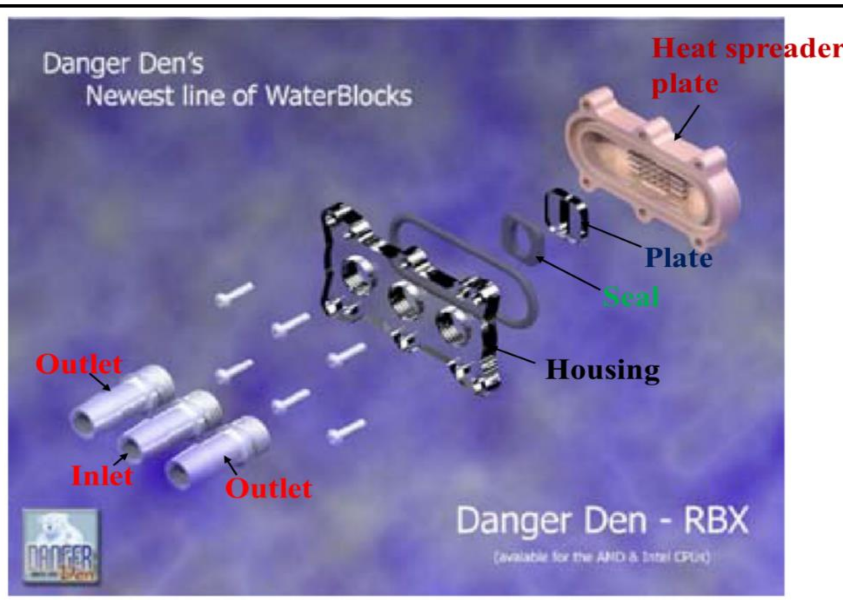
pieces that are connected — will remain the same. *Chang*, for example, discloses a fluid heat exchanger having separate housing and plate, *see Chang*, Fig. 4, but teaches that the housing and the plate "may effectively be integrated together to a plate which defines upper walls of the microchannels while facilitating connection of tubing to the microchannel assembly," *id.* at 6:58-63. Thus, a person skilled in the art in August 2007 would thus have known that whether the housing and the plate are continuous (as in the *Antarctica*) or are separate structures that are connected together (as in *Chang*) is a matter of design choice because the results and functions of the fluid heat exchanger will remain the same. That is, a person skilled in the art in August 2007 would have known that the principle of operation of the *Antarctica* can be implemented with separate plate and housing components that are connected together to form the fluid heat exchanger.

68. The Danger Den-RBX device, which was sold in the U.S. in 2004-2005, is a good example of a fluid heat exchanger having separate plate and housing components that are connected together to form the fluid heat exchanger. The Danger Den-RBX utilizes a split-flow arrangement where cooling fluid enters flow channels at midway along their lengths and exits at the ends of the channels. As shown below, the Danger Den-RBX is very similar to the *Antarctica* in structure, function, and operation, except that the Danger Den-RBX has separate housing and plate that are mated together with a seal therebetween, whereas the *Antarctica* has a single-piece housing and plate. Specifically, as shown below, the Danger Den-RBX has a **gasket (seal)** extending between the **housing** and the **plate**, which allows for better contact and sealing between the **housing** and the **plate**. The **seal** forces fluid to flow through the channels, instead of leaking or bypassing through gaps between the **housing** and the **plate**, and thus the **seal** separates the inlet and the outlet sides of the fluid heat exchanger.

CONTAINS INFORMATION THAT COOLIT HAS DESIGNATED HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY



Danger Den-RBX



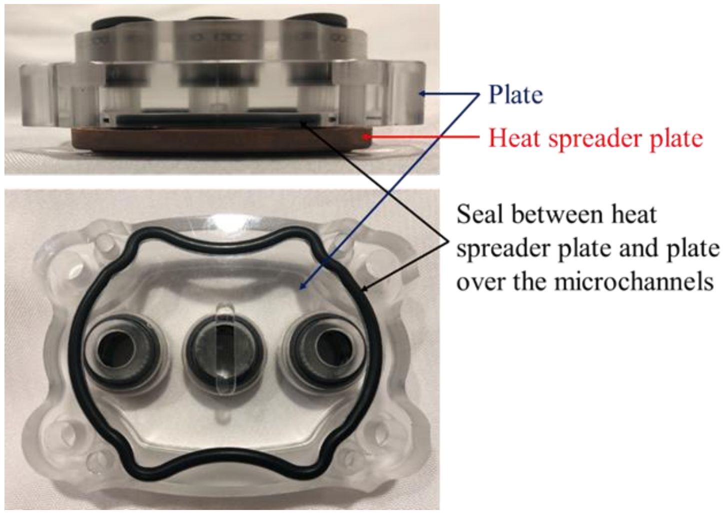
Exploded view of the Danger Den – RBX.

See ASE-CLT0054058 (annotations added).

69. As shown in the annotated figures of the Danger Den-RBX, above, cooling fluid enters the fluid heat exchanger through an **inlet** port in the **housing** and flows into the **inlet header** defined by the **plate** and the **seal**. From the **inlet header**, the cooling fluid enters the channels in the **heat spreader plate** (aka cold plate) via an **elongate opening/aperture** in the plate. The fluid exits the channels through openings at the ends of the channels and collects in **outlet headers** at respective ends of the channels. From the **outlet headers**, cooling fluid exits the fluid heat exchanger through **outlet** ports in the **housing**. Although the Danger Den-RBX does not include microchannels, it would have been obvious to replace the mini-channels (width ~ 1.66 mm) in the Danger Den-RBX with microchannels (having width <= 1 mm per the parties' construction of the term "microchannels") because the benefits of microchannels to heat transfer efficiency were well known by August 2007. Specifically, it was well-known in the field of microfluidics in 2007 that microchannels maximize the surface area-to-volume ratio and also provide high flow resistance (which correlates with high heat transfer coefficients), hence generally provide better heat transfer efficiency compared to macrochannels or minichannels. In fact, microchannels were used in high-performance heat sinks/fluid heat exchangers since the early 1980s. *See, e.g.*, Tuckerman Ph.D. Thesis, Bonde, Kandlikar, Bhatti, Antarctica, Kang, Hamilton, Chang, etc.

70. Moreover, it would have been obvious to provide a seal between the separate plate and housing of a modified *Antarctica* device to prevent leakage and fluid short-circuit between the inlet and the outlets. A person skilled in the art would also have reasonably expected success in modifying the *Antarctica* with a seal between the housing and the plate. The *Antarctica* device itself has an O-ring, i.e., a seal, extending between the plate and the heat spreader plate, as shown below, to provide fluid-tight contact between the two parts. A similar O-ring between the separate plate and housing of a modified *Antarctica* would have been an obvious design choice. In particular, it would have been obvious to provide a seal around the elongate inlet opening/aperture in the plate of a modified *Antarctica*, as in the Danger Den-RBX device, to provide better contact and sealing between the housing and the plate and to force fluid to flow through the

microchannel, instead of leaking or bypassing through gaps between the housing and the plate.



71. CoolIT admits that compliant seals, e.g., O-rings and gaskets, "were notoriously well-known long before August 9, 2007." *See* CoolIT '266 POR at 25 (CoolIT's Patent Owner Response in IPR2020-00825 against U.S. Patent 10,274,266 asserted in this case). Relying on *Zhang* (cited in CoolIT's expert's declaration supporting the Patent Owner Response in IPR2020-00825), CoolIT's expert also stated that "[s]eals made from compliant materials were notoriously well known long before August 9, 2007." Pokharna Decl., ¶67. *Zhang*, which was published in 2004, explicitly shows a microchannel heat sink having an "O-ring made of Viton" for "sealing" a cover plate (over the microchannels) and a housing having microchannels, as shown below. *Zhang* at 1474, 1476-77. The Danger Den-RBX device also included a compliant gasket between its housing and a cover plate (over the microchannels) to seal between the two parts.

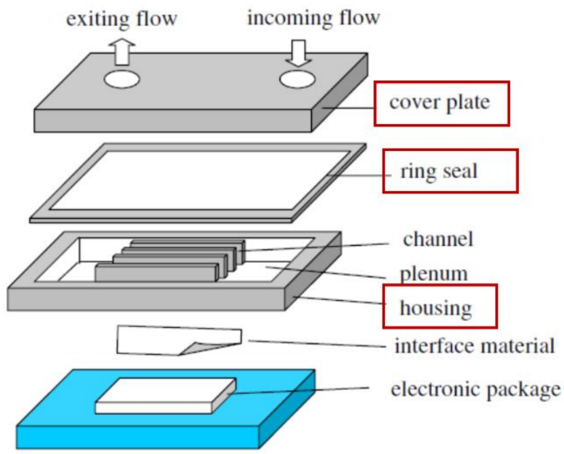


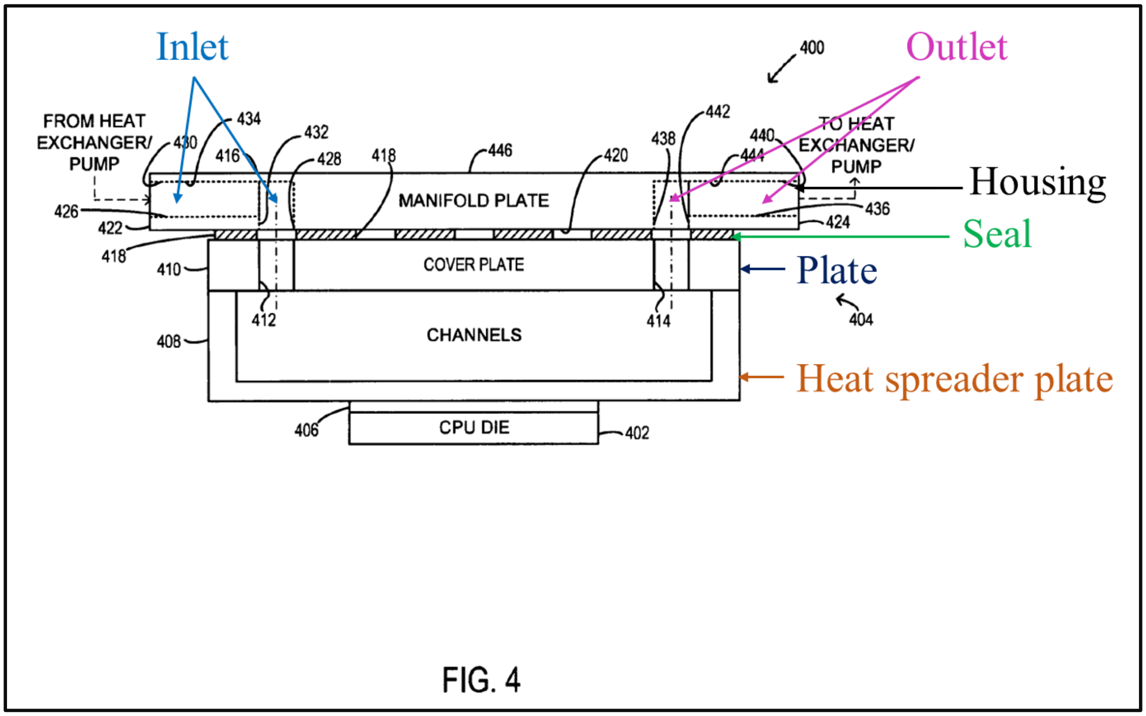
Fig. 1. Schematic diagram of the liquid cooling concept for electronic packages.

Zhang at 1474.

72. In sum, providing a seal between the separate housing and plate in a modified *Antarctica* device would have been obvious. A person skilled in the art would have been motivated to do so to provide a fluid-tight contact between the plate and the housing, and to force fluid to flow through the microchannels instead of short-circuiting the inlet and outlet sides by flowing through gaps between the housing and the plate. Providing a seal between mating parts of a fluidic device is a simple matter of engineering and common sense of those skilled in the art, not innovation.

D. *ANTARCTICA* IN VIEW OF *CHANG* RENDERS THE ASSERTED CLAIMS OF THE '330 PATENT OBVIOUS

73. The claim chart II in Exhibit A illustrates how *Antarctica* in view of *Chang* correlates with the limitations in independent claims 1, 12, and 14 and dependent claims 4 and 15. In my opinion, the *Antarctica* prior art device disclose each and every limitation of the asserted claims except a seal between the housing and the plate. *Chang* discloses every limitation of the asserted claims, including a seal extending between the housing and the plate. Specifically, *Chang* discloses a fluid heat exchanger having a separate housing and plate (unlike the single-piece housing and plate of the *Antarctica*). *Chang* further includes a seal extending between the housing and the plate, as shown below.



Chang, Fig. 4 (annotations added).

74. A person skilled in the art in August 2007 would have known been motivated to modify *Antarctica* in view of *Chang* to have a separate housing and plate and a seal therebetween because of the manufacturing advantages and cost-effectiveness of having separate housing and plate. As discussed above, having a separate housing and plate simplifies volume manufacturing of the fluid heat exchanger and allows for better manufacturing scalability. Additionally, the housing and the plate can be made of different materials — materials — for example, the plate might be made of a stamped metal sheet that bonds, solders, or seals best with the tops of the microchannel fins, and the bulkier housing (which has the inlets and the outlets) could be made of a cost-effective material such as plastic, thus reducing overall manufacturing costs. *See Chang*, 5:5-19. In fact, *Chang* specifically teaches that "[t]he manifold plate 416 [housing] may be more robust than a typical cover plate [plate] for a microchannel assembly and may reduce the possibility of breakage of the cover plate [plate], and may help to insure reliable tube connection. In general, the presence of the manifold plate [housing] may facilitate high volume manufacturing (HVM) with regard to the system." *Id.* at 6:13-19. These teachings of *Chang* about the benefits of separating the housing and the plate would have motivated a

person skilled in the art in August 2007 to modify *Antarctica* in view of *Chang* to have a separate housing and plate.

75. Another advantage of a separate housing and plate is that if there is a change in the configuration of the processor to be cooled (and a resulting change in the heat spreader plate configuration), then only the plate configuration needs to be revised to correspond to the changes in the heat spreader plate; the housing configuration can remain unchanged and the old plate can be swapped out for a new plate. *Chang* also teaches that "if it is desired to modify the configuration of the tubing and/or manner of connection of tubing to the microchannel assembly, such a modification maybe accommodated by a manifold plate [housing] having a different configuration, without requiring modification of the cover plate [plate]. In other words, the manifold plate [housing] may be tailored to match the desired orientation of inlet/outlet tubes, while keeping the cover plate [plate] and microchannel structure unchanged." *Chang*, 6:22-30.

76. Given the manufacturing and cost advantages of having separate housing and plate, a person skilled in the art in August 2007 would have been motivated to modify the *Antarctica* fluid heat exchanger in view of *Chang* to have separate parts/components forming the housing and the plate. Such a modification of the *Antarctica* would have only involved rearrangement/reconfiguration of prior art elements according to known methods to obtain predictable results, and as such a person skilled in the art would have reasonably expected success in such a modification.

77. Moreover, a person skilled in the art in August 2007 would have been motivated to provide a seal, e.g., an O-ring, gasket, etc., between the separate housing and plate of the modified *Antarctica* to provide better contact and sealing between the plate and the housing and thus minimize fluid leakage to the outside and/or minimize fluid bypass between the inlet and outlets through gaps between the housing and the plate. *See, e.g.*, Danger Den-RBX; *Chang*, 5:17-19, Fig. 4. In particular, it would have been obvious to provide a seal around the inlet openings in the plate of a modified *Antarctica*, as in the Danger Den-RBX device, to provide better contact and sealing between the housing and the plate and to force fluid to flow through the microchannel, instead of leaking or

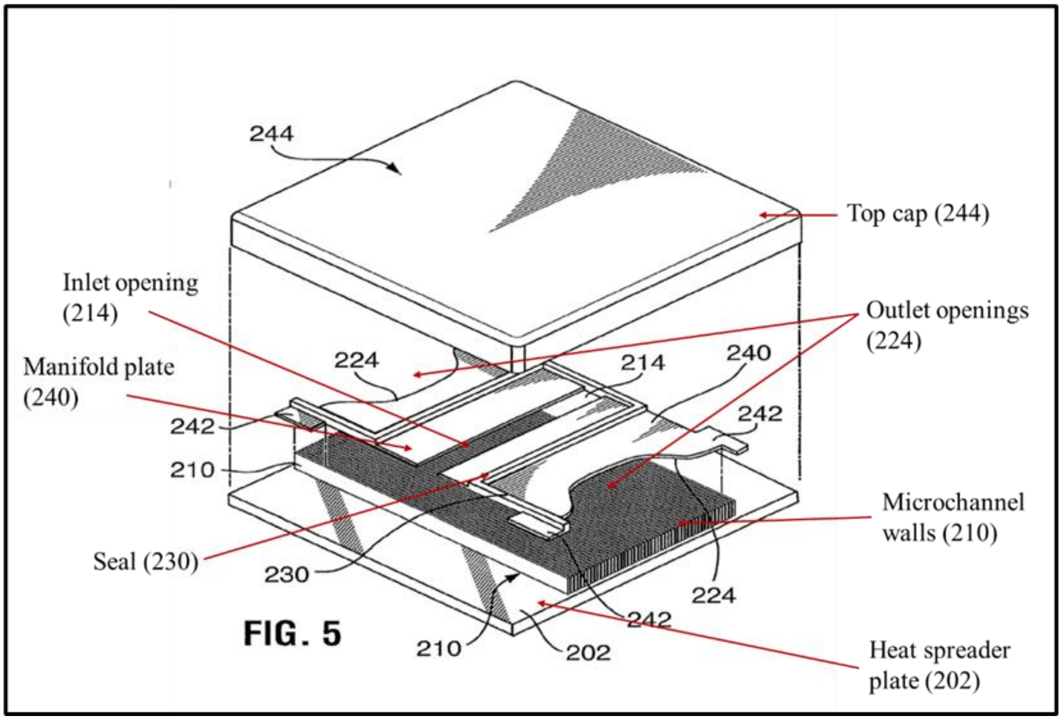
bypassing through gaps between the housing and the plate. Moreover, given the teachings of *Chang* and the common sense of providing a seal between two mating components of a fluidic device, a person skilled in the art would also have reasonably expected success in modifying the *Antarctica* with a seal between the housing and the plate.

IX. THE ASSERTED CLAIMS OF THE '284 PATENT ARE INVALID

A. BACKGROUND TECHNOLOGY OF THE '284 PATENT

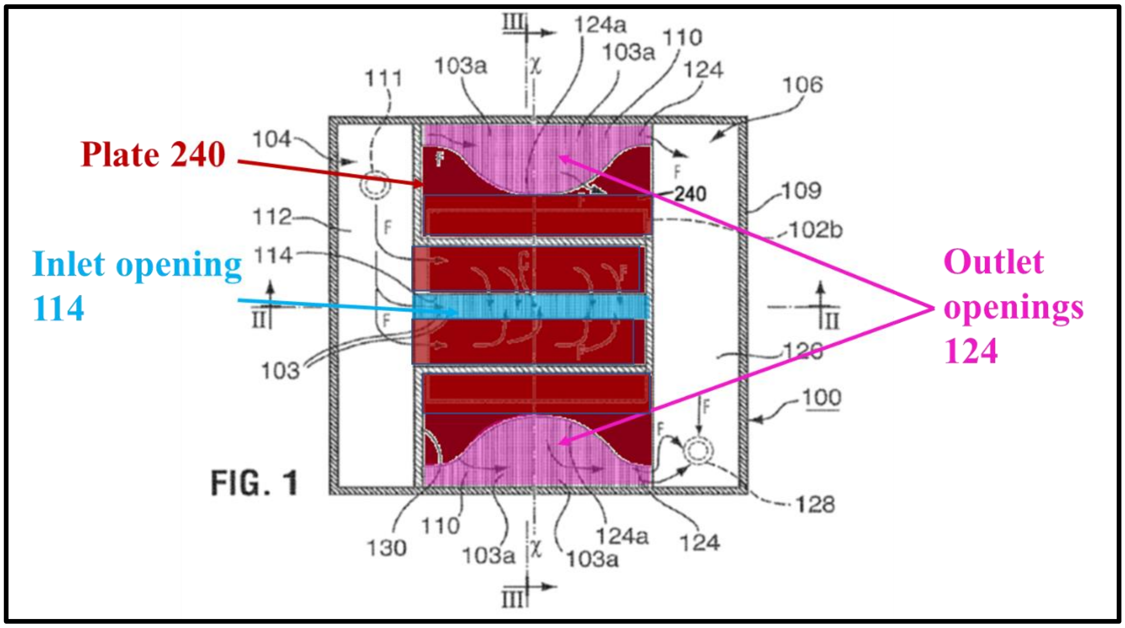
78. The specification of the '284 patent is identical to the '330 patent (only the claims are different). As with the '330 patent, the '284 patent describes a very specific structure/arrangement for a fluid heat exchanger 100 for cooling electronic devices. The fluid heat exchanger 100 includes 1) a heat spreader plate (cold plate) 102 having fins/walls 110 extending therefrom and defining microchannels 103 between adjacent walls; 2) a manifold plate 240 sitting on top of the walls 110 to close off the microchannels; and 3) a housing 109 having a recessed underside. '284 patent, 2:54-60, Figs. 1-3. The heat spreader 102 and the housing 109 together form the outer limits of the heat exchanger 100. *Id*. The housing 109 also includes inlet port 111 and outlet port 128 that lead to and from the fluid heat exchanger 100. *Id.* at Figs. 1-3.

79. Figures 4 and 5 illustrate a method of manufacturing fluid heat exchanger 100. A housing having a top cap 244 is placed over the heat spreader plate 202 and manifold plate 240 to form the heat exchanger, as shown in Figure 5 of the '330 patent (annotated below). '284 patent, 7:1-30. A seal 230 is provided between the manifold plate 240 and the underside of cap 244 to separate the inlet and the outlet sides of the fluid heat exchanger, to force liquid to flow from inlet opening 214 to outlet openings 224 through the channels defined between walls 210. *Id*. Seal 230 may be fused to the underside of cap 244 to prevent short circuiting of liquid from the inlet to the outlet side. *See id*.



'284 patent, Fig. 5 (annotations added).

80. The plate 240 includes cut-outs that form an elongate inlet opening 114 and two outlet openings 124 flanking the inlet opening 114. *Id.* at 4:11-5:43, Figs. 1-3. The inlet opening 114 sits approximately midway along the length of the microchannels and runs transverse to the length of the microchannels. *See id.* at Fig. 1. This creates a split-flow arrangement in which cooling liquid enters the microchannels at their mid-point through inlet opening 114, splits into two sub-flows and proceeds outwardly towards the pair of outlet openings 124 where the fluid exits the microchannels. *See id*.



Id. at Fig. 1 (annotations added).

81. The '284 patent describes that "the central region 124a of outlet openings 124 are scalloped to offer an enlarged outlet region from the centrally located channels, relative to those on the edges. This shaping provides that the outlet openings from some centrally positioned channels 103, relative to the sides of the heat exchanger, are larger than the outlet openings from other channels closer to the edges. This provides that fluid flowing through the more centrally located channels encounters less resistance to flow therethrough, again facilitating flow past the central mounting region 102b on heat spreader plate 102." *Id.* at 6:6:52-63.

82. I have been advised to use August 9, 2007 as the earliest priority date for the purposes of my analysis of the '284 patent, and to assume that the timeframe for the alleged invention of the '284 patent is on or around August 9, 2007.

B. SUMMARY OF PRIOR ART THAT RENDERS THE ASSERTED CLAIMS OF THE '284 PATENT INVALID

Antarctica

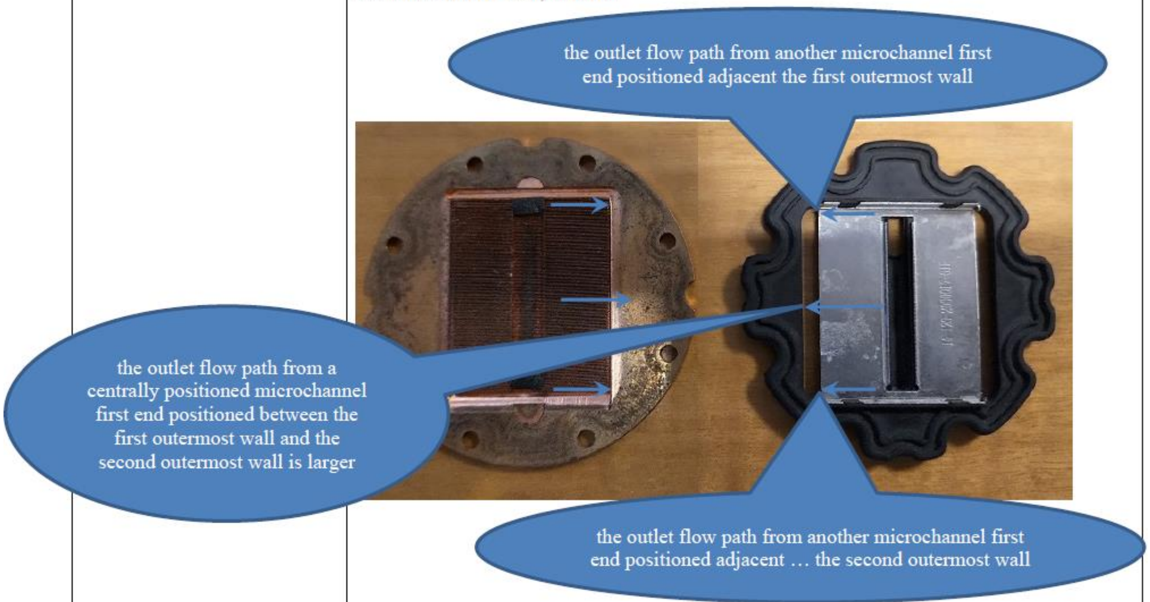
83. As discussed with regard to the '330 patent, Asetek invented and sold the Antarctica WaterChill™ CPU Cooler ("Antarctica") in the U.S. in 2004, i.e., prior to the August 9, 2007 priority date of the '284 patent. Therefore, *Antarctica* is prior art to the '284 patent.

84. My discussion of the *Antarctica* in Section VIII.B of this Report is incorporated herein by reference. With respect to the '284 patent, however, I have mapped the entire array of fins and microchannels on the heat spreader plate of the *Antarctica* as the recited "plurality of [spaced-apart] walls" and "plurality of microchannels," respectively.

85. As discussed above in Section VIII.B, the *Antarctica* has an elongate fluid inlet opening defined on the manifold plate over the microchannels. This elongate inlet opening further defines inlet flow paths into each of the microchannels on the heat spreader plate. Cooling fluid from the inlet header first flows in the elongate inlet opening in a direction transverse to the length of the microchannels. From the inlet opening, cooling fluid flows downward into the microchannels, splits into two sub-flows within each microchannel, and each sub-flow then proceeds outwardly towards the microchannel ends. Fluid exits the microchannels through openings at the ends of the microchannels and enters respective outlet headers, and from there the fluid exits the fluid heat exchanger through the dual outlet ports in the housing.

86. As I discussed above, it is unclear what is meant by "outlet flow path(s)" in the claims. In particular, the end of the recited "outlet flow path(s)" is unclear, nor is it clear whether the claim refers to the "outlet flow path(s)" in terms of length/distance or time. It appears from CoolIT's infringement contentions (shown below) that CoolIT is interpreting the "outlet flow path(s)" as the distance fluid travels in the outlet header (or to the outlet header) after exiting the microchannels before hitting a boundary wall of the heat exchanger.

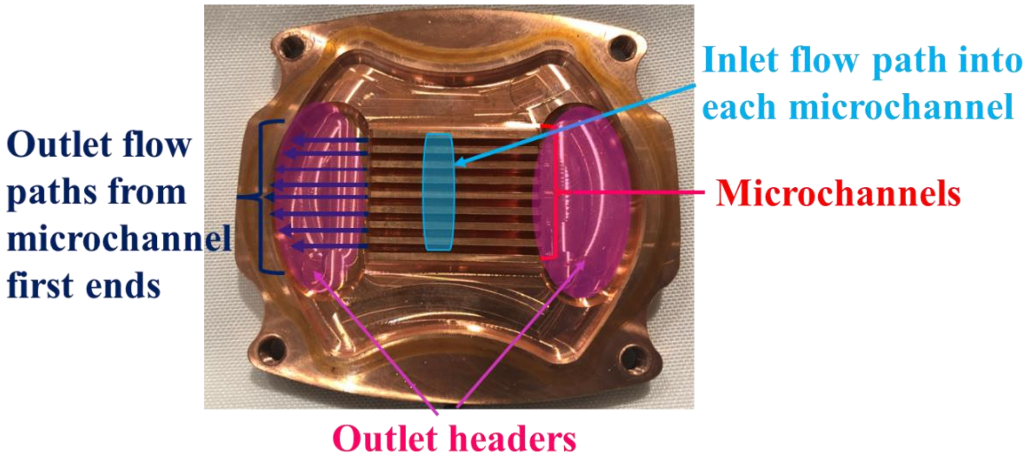
'284 Patent Claim	Evidence of Infringement
	wherein the outlet flow path from a centrally positioned microchannel first end positioned between the first outermost wall and the second outermost wall is larger than the outlet flow path from another microchannel first end positioned adjacent the first outermost wall, the second outermost wall, or both.



CoolIT's infringement contentions against Asetek's H55 product (which is a representative Gen 4 product having split flow) at p. 11.

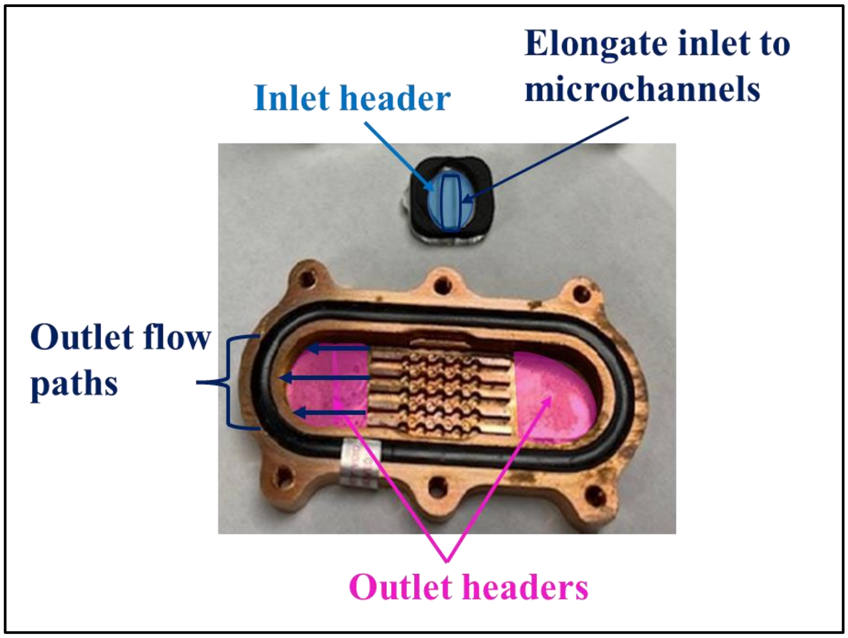
87. CoolIT's infringement contentions against accused Gen 5, 6, and 7 products similarly show that CoolIT is interpreting the "outlet flow path" as the distance fluid flows in the outlet header after exiting the microchannels through outlet openings at the microchannel ends and before contacting a boundary wall of the heat exchanger. But CoolIT's interpretation of "outlet flow path" is nowhere defined, explicitly or implicitly, in the '284 patent. Specifically, I do not agree with this interpretation because the end of an "outlet flow path" is not defined in the claims or in the specification of the '284 patent. Depending on where the "outlet flow path" ends, the lengths of the "outlet flow paths" will vary, such that in some cases the "outlet flow path" from a centrally-positioned microchannel first end may be longer than an outlet flow path from an outer microchannel first end, and in other cases it may be shorter. Flow paths will also fluctuate from moment to moment wherever turbulent flow exists.

88. Regardless, based on CoolIT's interpretation of "outlet flow path," even though I do not agree with it, I have shown below (and in Chart I) that an outlet flow path from a centrally-positioned microchannel first end of the *Antarctica* is longer than an outlet flow path from an outer microchannel first end. This difference in the outlet flow paths results from the bean-shaped structure of the outlet headers in the *Antarctica*, where the header is wider at the center and narrower at the apex and base. As a result, cooling fluid has to travel further at a central region of each outlet header as compared to the distance fluid travels near the apex and base of each outlet header.



89. The Danger Den-RBX similarly shows (based on CoolIT's interpretation of "outlet flow path") that an outlet flow path from a centrally-positioned channel first end is longer than an outlet flow path from an outer channel first end. This is because of the "D-shape" of the outlet headers, which results in cooling fluid exiting from a central channel to travel a longer distance in the outlet header before hitting a boundary wall of the fluid heat exchanger as compared to the distance traveled by fluid exiting from the outer channels.

CONTAINS INFORMATION THAT COOLIT HAS DESIGNATED HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY



Danger Den-RBX

Bhatti

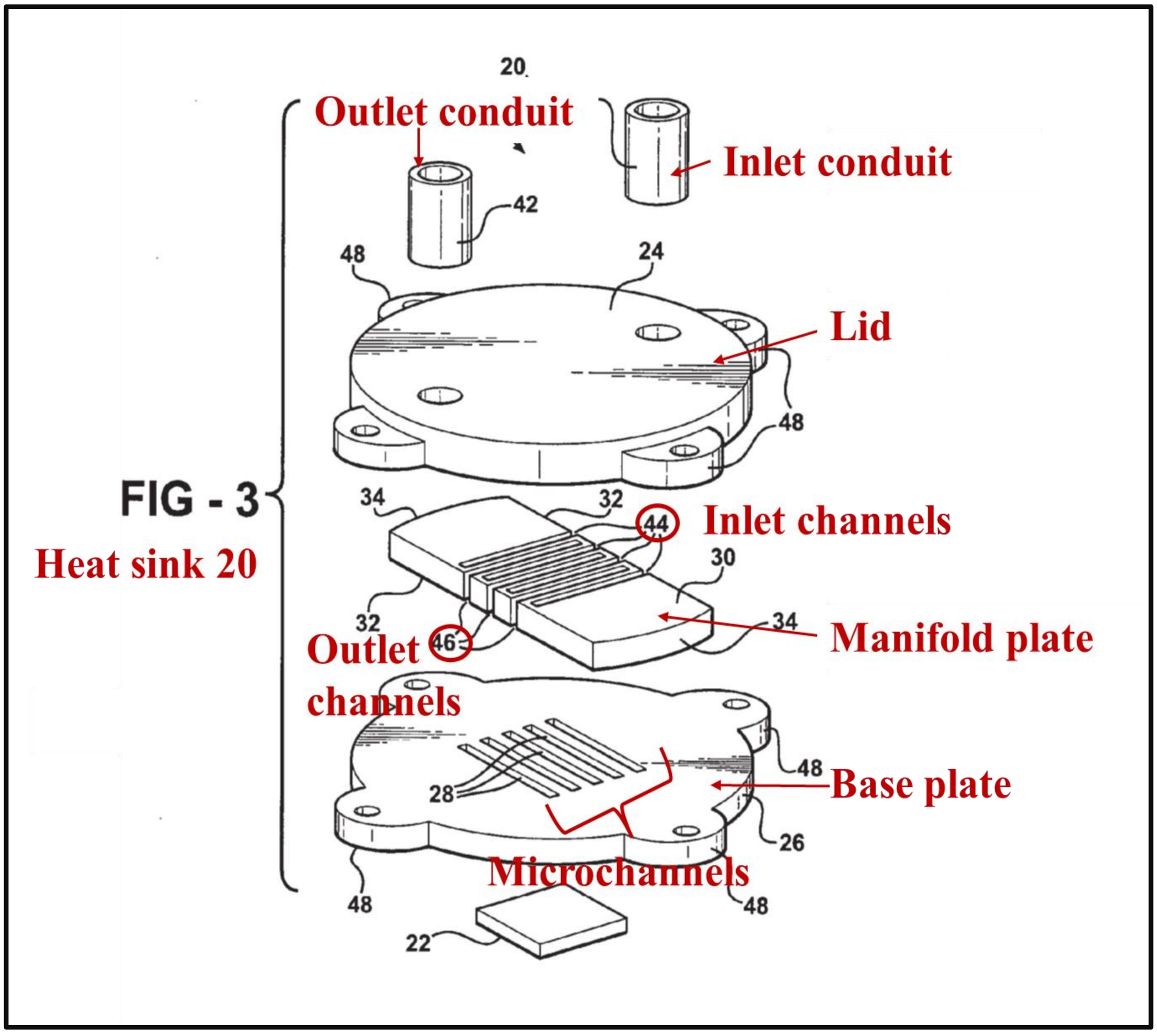
90. U.S. Patent Publication No. 2007/0163750 to Bhatti et al. ("Bhatti") was filed on January 17, 2006 and published on July 19, 2007. Therefore, *Bhatti* is prior art to the '284 patent.

91. *Bhatti* is directed to a fluid heat exchanger (heat sink 20) for transferring heat from a heat source to a cooling fluid. *Bhatti*, ¶[0002]. Heat sink 20 is defined by a housing having a lid 24 and a base plate 26, which serves as a cold plate. *Id.* at Fig. 1, ¶[0016]. Base plate 26 comprises a plurality of parallel microchannels 28 of equal length. *Id.* A manifold plate 30 is provided between lid 24 and base plate 26 and overlies microchannels 28. *Id.* at ¶[0017]. Manifold plate 30 comprises a plurality of interleaved inlet channels 44 and outlet channels 46. *Id.* at ¶[0018], Fig. 1.

92. *Bhatti's* heat sink 20 comprises an inlet plenum (defined between a shoulder 36 of the lid and the inlet edge 32 of manifold plate 30) and an outlet plenum (defined between shoulder 36 and the outlet edge 32 of manifold plate 30). *Bhatti*, Figs. 1 and 2, ¶[0017]. The inlet plenum of *Bhatti* is positioned on one side of microchannels 28 and manifold

plate 30, and the outlet plenum is positioned on the opposite side of the plate and microchannels. *Id.*

93. The inlet channels 44 of *Bhatti* extend transversely from the inlet edge towards the outlet edge of manifold plate 30 across the plurality of microchannels. *Id.* at Figs. 1 and 2, ¶[0018], ll. 1-5. Similar, the outlet channels 46 extend transversely from the outlet edge towards the inlet edge of manifold plate 30 across the plurality of microchannels 28. *Id.* The plurality of inlet and outlet manifold channels create multiple split flow arrangements throughout the fluid flow path of each microchannel 28. *Id.* at Figs. 4 and 5, ¶[0018], ¶[0020], ll. 1-10; ¶[0021]. Cooling fluid flows from inlet conduit 40 into the inlet plenum and into inlet channels 44 of the manifold plate, where the flow is forced downwards into the microchannels. *Id.* at Fig. 5, ¶[0020], ll. 1-10, ¶[0021]. Inlet channels 44 therefore define inlet flow paths into each of the microchannels 28. Fluid flows through the microchannels for a short distance and is redirected up into the outlet channels 46 of manifold plate 30 and out into the outlet plenum for exit out of outlet conduit 42. *Id.* Outlet channels 46 therefore defines outlet flow paths from each of the microchannels 28. Based on CoolIT's interpretation of "outlet flow path" in its infringement contentions (discussed above), even though I do not agree with it, I have shown in Chart II that an "outlet flow path" from a centrally-positioned microchannel first end of the *Bhatti* device is longer than an "outlet flow path" from an outer microchannel first end. This difference in the outlet flow paths results from the fluid having to travel longer to reach the outlet plenum (or travel through the outlet plenum to outlet conduit 42) after exiting a microchannel at a position "O" in outlet channel 46 (*see Bhatti*, Fig. 4).



Bhatti, Fig. 3 (annotations added).

Kang

94. U.S. Patent Publication No. 2006/0096738 to Kang et al. ("Kang") was filed on February 8, 2005 and published on May 11, 2006. *Kang* is therefore prior art to the '284 patent.

95. *Kang* discloses a fluid heat exchanger. *Kang*, Title, Abstract. The heat exchanger comprises a metal cooling plate 10 having a heat transfer surface 12 on one side and a heat collection surface 11 on the other side, with heat collection surface 11 placed in thermal contact with a heat source. *Id*. at Abstract, ¶¶[0003], [0028].

96. As shown in Figures 1 and 3 of *Kang*, a cooling chamber 30 is formed over the heat transfer surface 12. Cooling chamber 30 comprises a cover 20 with a top 22 and a circumferential wall 24 forming a housing around the cooling plate. *Id*. at Figs. 1-3. Cooling chamber 30 includes an inlet port 27 (with inlet nipple 26) and an outlet port 29 (with outlet nipple 28) and inlet and outlet sections 31, 33 *Id.* at Abstract, ¶¶[0003], [0028]-[0029], Figs. 1-3.

97. Cooling plate 10 of the *Kang* device comprises an array of parallel microfins 14 on heat transfer surface 12. *Id.* at ¶[0028], Fig. 1. Microfins 14 define a plurality of parallel microchannels between the adjacent fins. *Id.* at ¶ [0030].

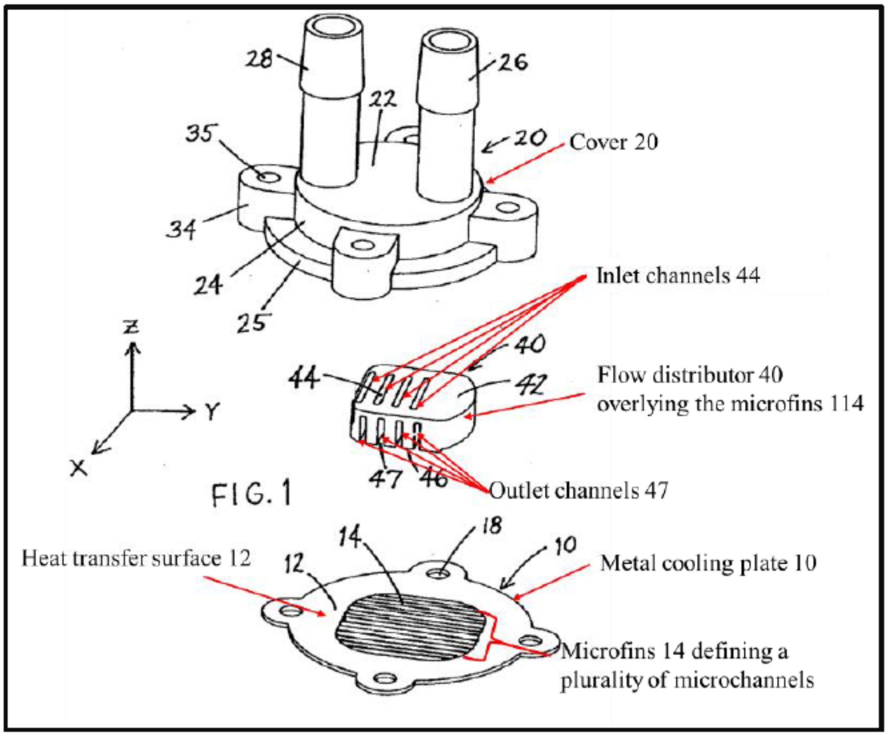
98. To the extent *Kang* is found to not explicitly disclose that the channels formed between adjacent microfins 14 are "microchannels," one skilled in the art in August 2007 would have readily recognized that that microfins 14 form microchannels between adjacent fins. It was well-known in the field of microfluidics in 2007 that microchannels maximize the surface area-to-volume ratio and also provide high flow resistance (which correlates with high heat transfer coefficients), hence generally provide better heat transfer efficiency compared to macrochannels or minichannels. *See, e.g., Kandlikar*, pp. 5, 7, 8-10; *Kang*, ¶[0009]. Accordingly, it would have been an obvious and a trivial modification for a skilled artisan to form microchannels (in place of macro- or mini-channels) on heat transfer surface 12 of the heat exchanger of *Kang* to enhance thermal transfer. Moreover, Kang specifies that the parallel microfins which define the channels "may have a height of as little as 0.001 in or less" which necessarily implies that the hydraulic diameters of the channels are far less than 1 mm, hence are bona fide microchannels having very high heat-transfer coefficients.

99. A flow distributor 40 is provided between microfins 14 and cover 22. *Kang*, Figs. 1-3. The flow distributor 40 sits on top of the cooling plate 10 such that the lands 46 of flow distributor 40 are "in contact with the tops of the fins" 14 upstanding from the surface 12 and the edges of flow distributor 40 are pressed against a shoulder 39 of cover 20. *Id.* at ¶¶[0029], [0030], Figs. 1, 3. Flow distributor 40 comprises alternating inlet and outlet openings 44, 47 into and out of the channels on cooling plate 10. *Id.* at ¶¶[0007]-[0008],

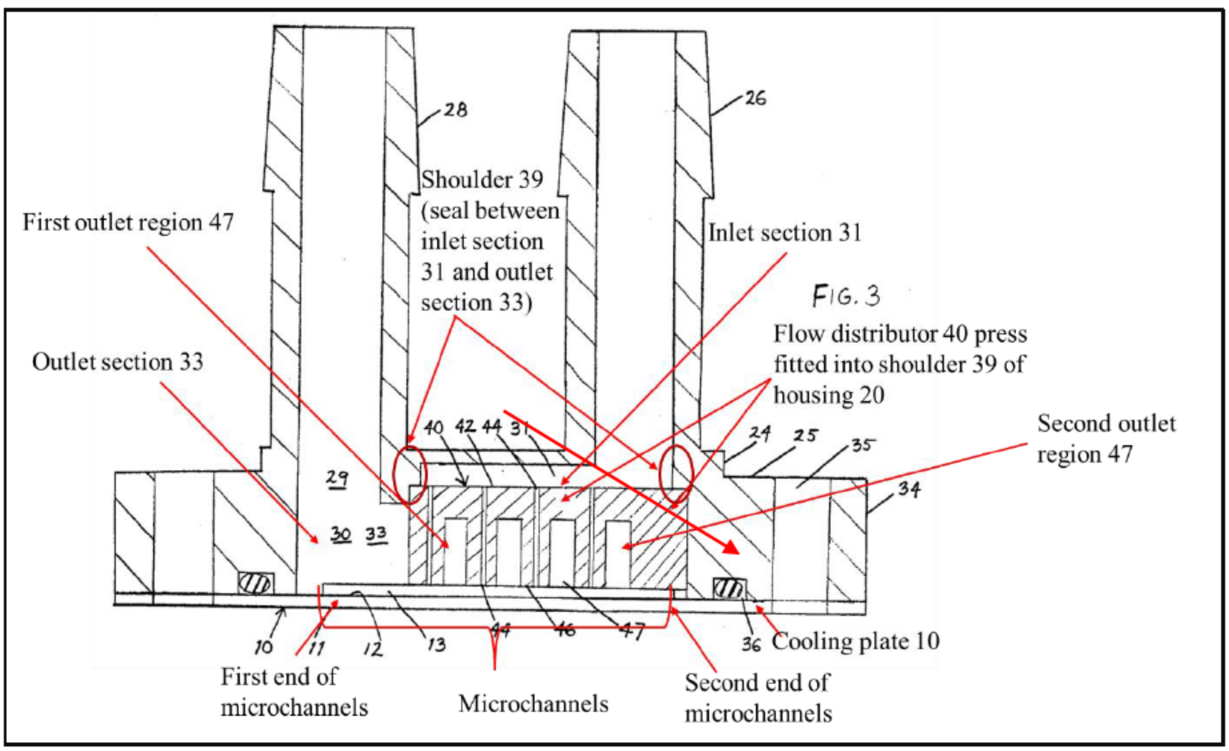
[0029]. An inlet section 31 is positioned on the topside of microfins 14 over the flow distributor 40 and outlet section 33 is positioned along a lateral side of microfins 14 and flow distributor 40. *Id.* at Fig. 3. Inlet section 31 extends over and connects all inlet openings 44 of flow distributor 40. *Id*. at ¶¶[0007]-[0008], Fig. 3. The plurality of outlet openings 47 communicate with outlet section 33. *Id.* at Fig. 3, ¶ [0029].

100. The plurality of elongate inlet openings 44 receives coolant from inlet port 27 via inlet section 31. *Id*. In addition, "the flow distributor 40 serves as a dividing wall between the inlet section 31 and the outlet section 33 of the cooling chamber 30." *Id.* at ¶[0029], Fig. 3. A skilled artisan in August 2007 would have known and understood that flow distributor 40 along with shoulder 39 separates the inlet and outlet sections by preventing fluid bypass between the inlet and outlet sections through gaps between the plate and the housing, and forcing fluid to instead flow through the microchannels. *See id.* at ¶¶[0028], [0029], Fig. 3.

101. Coolant from inlet section 31 first travels downward (in the Z-direction) through inlet openings 44 of flow distributor 40 into the channels, then splits into two sub-flows and flows a short distance through the channels (gaps) formed between the fins (in the Y-direction), and then through outlet openings 47 (in the X-direction) towards outlet section 33, from where the coolant exits cooling chamber 30 through outlet port 29. *Id.* at ¶[0030], Fig. 1 (showing the rectangular coordinates).

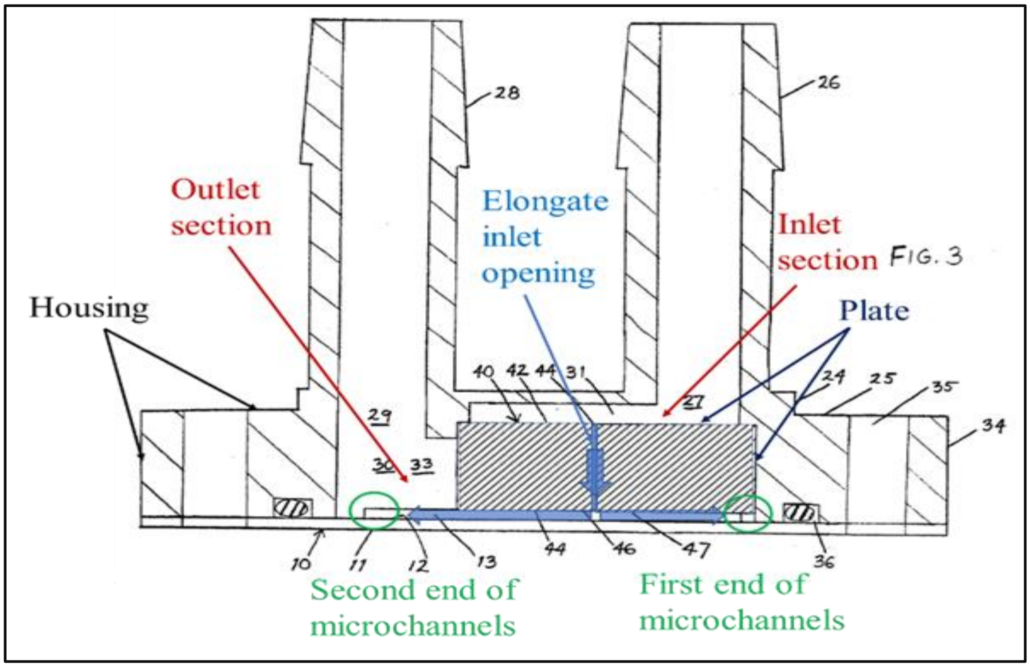


Kang, Fig. 1 (annotation added).

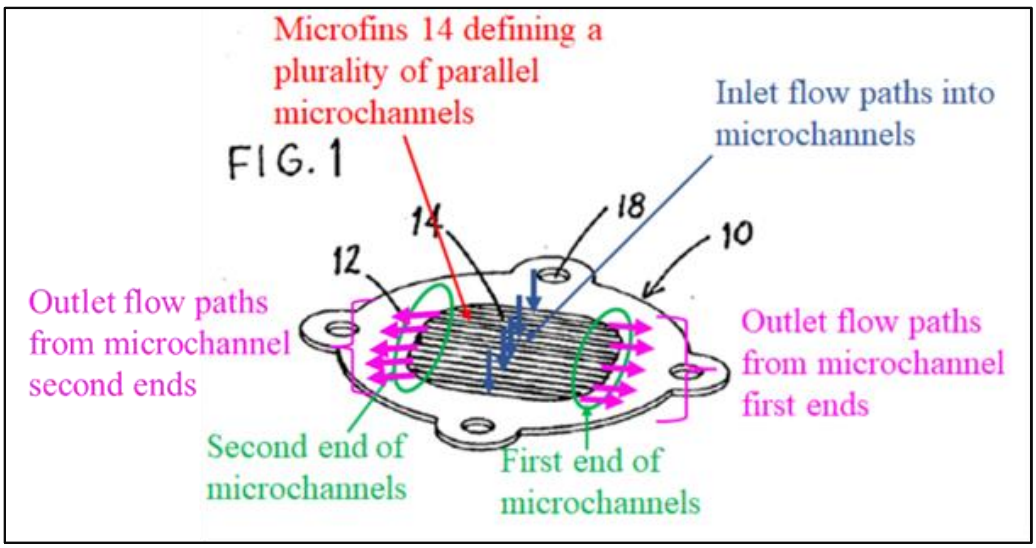


Id. at Fig. 3 (annotations added).

102. Flow distributor 40 of *Kang* creates multiple split-flows throughout the length of each microchannel, which reduces the fluid flow path through the microchannels, and thereby lowers pressure drop and flow resistance through the channels, which increases flow velocities and interrupts the development of the thermal boundary layer, thereby enhancing heat transfer. *Id.* at ¶¶[0013]-[0014]. One skilled in the art in August 2007 would have recognized that if *Kang's* flow distributor 40 included only a single inlet channel 44 and two outlets at the respective microchannel ends (instead of having a series of alternating inlet and outlet channels), then coolant will enter the microchannels through the single inlet channel 44, split into two sub-flows and proceed outwardly towards the outlets at the opposite ends of the microchannels, as shown below. Such single split-flow arrangement (i.e., a single inlet and two outlets) was well-known before August 2007, and a person skilled in the art would have been motivated to modify Kang to have single split flow for simplicity and easy manufacturability. *See Kandlikar, Bonde, Hamilton, Antarctica, Danger Den-RBX,* etc. The single inlet channel 44 would create inlet flow paths into each microchannel, and the outlets at the microchannels ends would create outlet flow paths from the first and second ends of the microchannels. Based on CoolIT's interpretation of "outlet flow path" in its infringement contentions (discussed above), even though I do not agree with it, I have shown in Chart III that an "outlet flow path" from a centrally-positioned microchannel first end of the *Kang* device is longer than an "outlet flow path" from an outer microchannel first end. This difference in the "outlet flow paths" results from the fluid having to travel further to reach the outlet section 33 after exiting a centrally-positioned microchannel compared to the distance fluid travels to reach outlet section 33 from an outer microchannel.



Id. at Fig. 3 (modified to have a single elongate inlet opening and two outlets; annotations added).

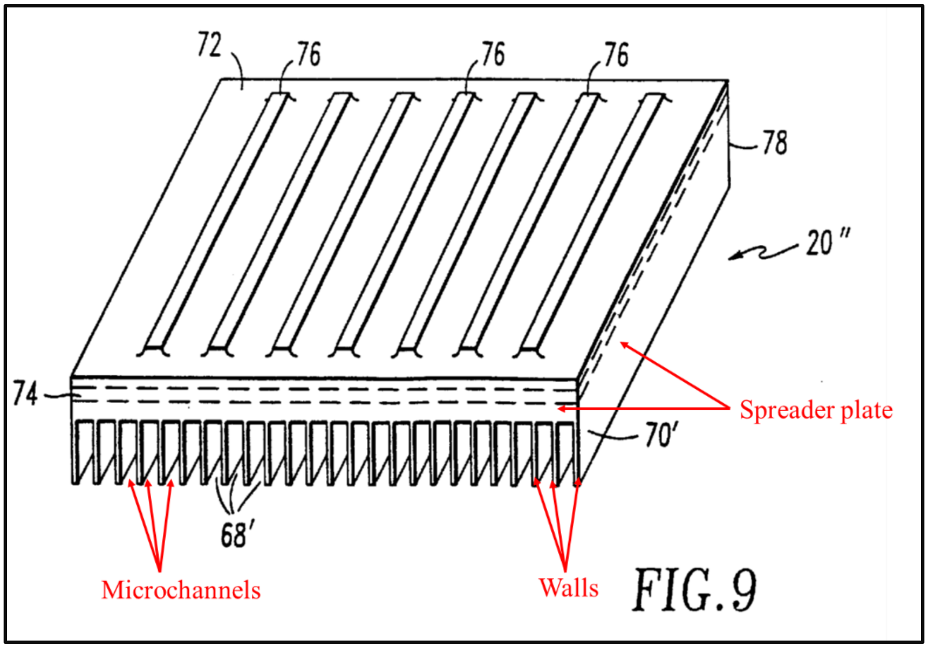


Id. at Fig. 3 (modified to have a single elongate inlet opening and two outlets; annotations added).

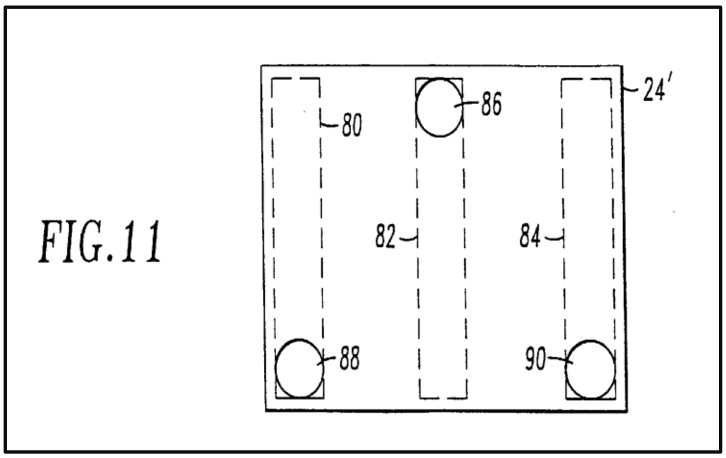
<u>Hamilton</u>

103. U.S. Patent No. 5,998,240 to Hamilton et al. ("Hamilton") was issued on December 7, 1999. Therefore, *Hamilton* is prior art to the '284 patent.

104. *Hamilton* discloses a microchannels-based heat sink for cooling densely packed semiconductor chips. *Hamilton*, Abstract, 2:1-17, 4:44-52. According to *Hamilton*, "microchannels maximize heat sink surface area and provides improved heat transfer coefficients, thereby allowing a higher power density of semiconductor devices without increasing junction temperature or decreasing reliability." *Id.* at Abstract, 2:1-17. *Hamilton* discloses an embodiment where a silicon chip/die 20" contains a heat spreader region 78 directly underneath a plurality of integrated insulated gate bipolar transistors (IGBTs). *Id.* at Fig. 9. The heat sink includes a plurality of fins 70' formed on the spreader 78. *Id.* The fins 70' form a plurality of microchannels 68' therebetween. *Id.* The heat sink includes a ceramic frame 24' (also referred to as substrate 24') that is positioned over the fins 70' to close off the microchannels 68'. *Hamilton*, Figs. 9, 11, 12. Substrate 24' includes a coolant inlet port 86, coolant outlet ports 88 and 90, and rectangular coolant manifolds 80, 82, 84. *Id.* at 6:44-59. The coolant manifold 82 defines inlet flow paths into each of the microchannels 68', and the manifolds 80 and 84 define outlet flow paths from each of the microchannel first ends and second ends. Based on CoolIT's interpretation of "outlet flow path" in its infringement contentions (discussed above), even though I do not agree with it, I have shown in Chart IV that an "outlet flow path" from a centrally-positioned microchannel first end of the *Hamilton* device is longer than an "outlet flow path" from an outer microchannel first end. This difference in the outlet flow paths results from the fluid having to travel longer/farther in the outlet manifold 80 (or travel through outlet manifold 80 to reach outlet port 88) after exiting a centrally-positioned microchannel (as compared to the distance fluid travels after exiting a microchannel near outlet port 88).



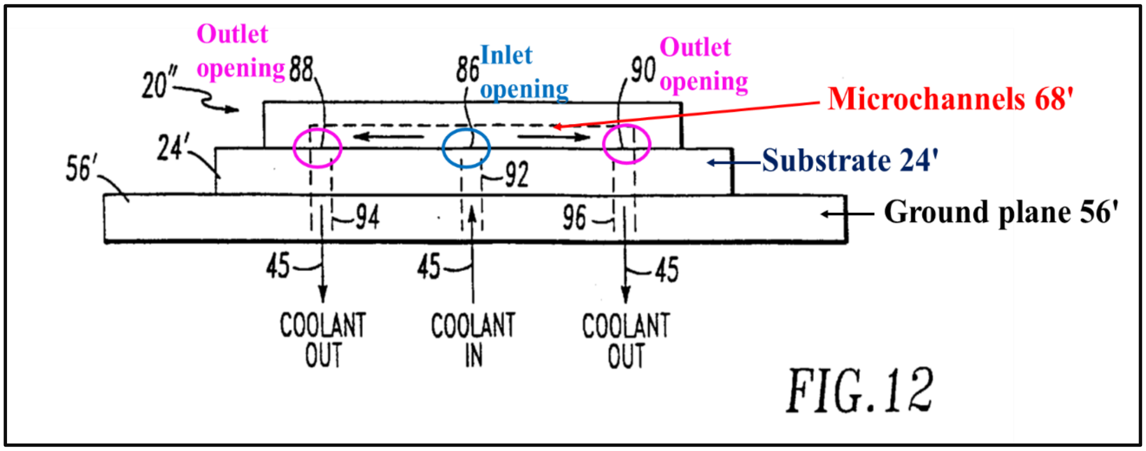
Hamilton, Fig. 9 (annotation added).



Id. at Fig. 11.

105. The heat sink further includes a ground plane 56' positioned over and spaced apart from substrate 24'. *Id.* at Figs. 12; 2:9-13 ("[A] plurality of microchannels are formed directly in the substrate portion or die of a silicon or silicon carbide chip mounted on a ground plane element of a circuit board and where a liquid coolant is fed to and from the microchannels through the ground plane."): 6:54-59. The ground plane has a coolant input duct 92 and two outlet ducts 94 and 96. *Id.* at Fig. 12, 6:54-59. The input duct 92 is in fluid communication (via port 86 and manifold 82 of substrate 24') with each respective inlet flow path into the microchannels 68', and the output ducts 94,

96 are in fluid communication (via manifolds 80, 84 and ports 88, 90 of substrate 24') with each respective outlet flow path from the microchannel first ends and second ends. *Id.* at Figs. 11 and 12. Cooling fluid entering each microchannel 68' splits into two sub-flows, and each sub-flow then proceeds outwardly towards the respective microchannel first end and second end. *See id.* at Fig. 12.



Id. at Fig. 12 (annotation added).

C. THE ASSERTED '284 PATENT CLAIMS ARE INVALID FOR LACK OF WRITTEN DESCRIPTION AND ARE INDEFINITE

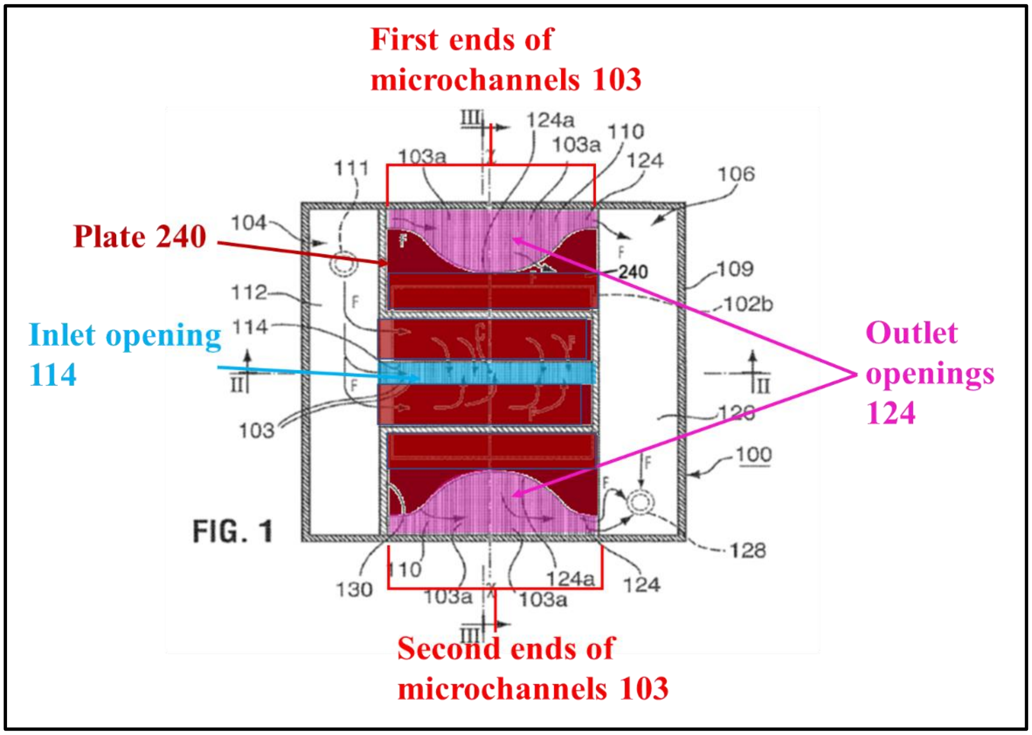
106. Independent claims 1 and 15 recite an "outlet flow path" from each of the "microchannel first end." Claim 1 further recites that "the outlet flow path from a centrally positioned microchannel first end positioned between the first outermost wall and the second outermost wall is larger than the outlet flow path from another microchannel first end positioned adjacent the first outermost wall, the second outermost wall, or both." Claim 15 similarly recites that "the outlet flow path from a centrally located first end is larger than the outlet flow path from a first end spaced apart from the centrally located first end." But the term "outlet flow path" appears nowhere in the '284 patent specification. Now does the '284 patent specification provide any disclosure of how the "outlet flow path" from a centrally-positioned microchannel first end is larger than the "outlet flow path" from an outer microchannel.

107. To be sure, the '284 patent specification describes that the scalloped-shape of the outlet openings 124 provide that "the *outlet openings* from some centrally positioned channels

103, relative to the sides of the heat exchanger, are larger than the *outlet openings* from other channels closer to the edges." '284 patent, 6:52-63 (emphases added), Fig. 1 and 5. But an "outlet opening" is different from an "outlet flow path." The '284 patent claims draw a distinction between an "outlet flow path" and an "outlet opening." *See* claim 1 (reciting "outlet opening" and "outlet flow path" as separate claim limitations); *see also* claim 29 (reciting that the "outlet opening[s]" from the outermost microchannels are smaller "compared to openings from a centrally located microchannel," thus differentiating the "outlet flow path[s]" recited in claims 1 and 15 and the "outlet openings" recited in claim 29). The discussion of "outlet openings" therefore does not provide any clarity or explanation about how an "outlet flow path" from a centrally-positioned microchannel first end is larger than an "outlet flow path" from a microchannel adjacent the outermost edges of the plate.

108. Moreover, since claims 1 and 15 recite that the "outlet flow path[s]" extend from or adjacent a first end of the microchannel, the scallop-shape of the outlets 124 are irrelevant. This is because the scallop-shape is predominantly in the "central region 124a of outlet openings 124," and not adjacent the first ends of the microchannels where the recited "outlet flow path[s]" must begin. *See* '284 patent, 6:52-56, Fig. 1 (annotated below to show the ends of the microchannels). In other words, the scalloped-shaped outlet openings 124, which overlay microchannels 103, do not overlap or intersect with the claimed "outlet flow path[s]" which begin at the ends of the microchannels.

109. Accordingly, there is no written description support for the limitations reciting "outlet flow path[s]" in independent claims 1 and 15. Thus, asserted claims 3, 5, 15, and 20 are invalid for lack of written description.



Id. at Fig. 1 (annotations added).

110. The limitations reciting an "outlet flow path" from or adjacent a "microchannel first end" in claims 1 and 15 are also indefinite because the ends or the flow directions of the "outlet flow path[s]" are not defined in the claims, and therefore the metes and bounds of the claims are not reasonably certain. Specifically, neither the claims nor the specification of the '284 patent define where the "outlet flow path[s]" end or which way the "outlet flow path[s]" extend after exiting the microchannel ends, and without such description, a person skilled in the art cannot reasonably determine whether or not an "outlet flow path" from a centrally-positioned microchannel first end is larger than an "outlet flow path" from an outer microchannel. Depending on where the end of the "outlet flow path" is chosen to be, a given product may either infringe or not infringe claims 1 and 15, which makes these claims (and their dependent claims 3, 5, and 20) indefinite.

111. In fact, the inventor of the '284 patent, Mr. Geoff Lyon, agreed in his deposition that claims 1 and 15 do not define the ends of the "outlet flow path[s]" from the microchannels and that the "outlet flow path[s]" would be different in different embodiments:

Q. So you're defining "outlet flow path" as the entire length of flow from the point the liquid exits the microchannel all the way to an outlet port; is that right?
A. So the outlet flow is defining a road, you know, from -- a path. You could be on that path for a short time, a long time. But, you know, yes, that would be the outlet flow, I suppose.
Q. Just so I'm clear, the outlet flow path is the entire length of path from the point the liquid exits the microchannel all the way to an exit port through which liquid exits the exchanger; is that right?
MR. CHEN: Objection. Calls for a legal conclusion.
THE WITNESS: That would be, you know, at least part of the outlet flow path. Could be all of it. I guess it depends on where you have the start and begin and end.
BY MS. BHATTACHARYYA:
Q. **So sitting here today, can you define the beginning and the end of the outlet flow path?**
MR. CHEN: Objection. Asked and answered. Calls for a legal conclusion.
THE WITNESS: **I cannot define it.**
BY MS. BHATTACHARYYA:
Q. So it's not clear what the beginning and the end of the outlet flow path is, right?
A. I believe the beginning of the outlet flow path is when it comes out of the microchannels.
Q. What is the end of the outlet flow path?
MR. CHEN: Objection. Calls for a legal conclusion. Vague and ambiguous.
THE WITNESS: As it relates to the picture I'm looking at, I would suppose 128, the outlet port.
BY MS. BHATTACHARYYA:
Q. **As it relates to claim 1 of the '284 patent, what is the beginning and the end of the outlet flow path?**
MR. CHEN: Objection. Calls for a legal conclusion. Incomplete hypothetical.
THE WITNESS: I'm going to read it again

> to see if I can answer this for you.
> (Reviews document.)
> **I believe the outlet flow path is not specific in where it ends**.

Lyon Dep. Tr., 102:13-104:12 (emphasis added); *see also id.* at 107:24-109:10 (agreeing that claim 15 does not define the end of the "outlet flow path" and that the "outlet flow path" could be different for different embodiments). Mr. Lyon also conflates time and distance in the above testimony. It may take fluid a long time to travel a short distance in the laminar boundary layers due to the "no-slip" condition at or near the walls of the fluid heat exchanger.

112. Claim 1 and 15 (and their dependent claims) are also indefinite because it would not be reasonably possible to determine the precise outflow path of fluid after it exits the microchannels. This is because cooling fluid often becomes turbulent (i.e., nonlaminar flow) in the fluid heat exchanger, particular in the header regions, and so fluid exiting the ends of the microchannels will mix in the outlet headers on its way to the outlet ports. Therefore, a person skilled in the art cannot determine with reasonable certainty the length/distance traveled by a particular packets of fluid after it exits a centrally-located microchannel versus the length/distance traveled by a different packet of fluid after it exits an outer microchannel.

113. Given that claims 1 and 15 do not define the ends of the recited "outlet flow path[s]," a person skilled in the art would not reasonably know the length or direction of flow of the claimed "outlet flow path" from these claims. Nor would it be possible to determine the exact flow path of fluid in the outlet header after exiting the microchannels. And as agreed by Mr. Lyon, the "outlet flow path" would be different for different embodiments depending on where the end of the "outlet flow path" is selected to be. *Id.* at 107:24-109:10. Therefore, in my opinion, the scope of claims 1 and 15 are not reasonably certain and these claims (and their dependent claims) are invalid as indefinite and for lack of written description.

D. THE *ANTARCTICA* DEVICE RENDERS THE ASSERTED CLAIMS OF THE '284 PATENT OBVIOUS

114. The claim chart I in Exhibit B illustrates how the *Antarctica* correlates with the limitations in the asserted claims of the '284 patent. In my opinion, the *Antarctica* prior art device disclose each and every limitation of the asserted claims except a "seal" (i.e., "a component that fills a gap to prevent leakage through the gap" per the Court's construction) between the housing and the plate. This is because the housing and the plate of the *Antarctica* fluid heat exchanger comprise a continuous/monolithic structure, so a separate gasket or O-ring between the housing and the plate are not needed to create a fluid-tight contact between them. But as discussed in Sections VIII.C and D, having the housing and the plate as separate components that are sealed would have been an obvious modification of the *Antarctica* prior art device, particularly based on the state of the art shown in the prior art *Chang* and *Danger Den-RBX* device, and the general knowledge and common sense of one skilled in the art. I am incorporating here my discussions in Sections VIII.C and D about why a skilled artisan in August 2007 would have been motivated to modify the *Antarctica* to have the housing and the plate as separate components that are sealed to prevent fluid bypass or leakage through the gaps therebetween, and would also have had a reasonable expectation of success in such a modification.

E. *BHATTI* ANTICIPATES OR RENDERS OBVIOUS THE ASSERTED CLAIMS OF THE '284 PATENT

115. As discussed in Exhibit B, Chart II, *Bhatti* anticipates each and every element of claims 1, 3, 4, and 5. If CoolIT argues that *Bhatti* does not disclose the "seal" between the housing and the plate as recited in claim 1 (although I disagree with such an argument), it would have been obvious to one skilled in the art in August 2007 to provide an O-ring or another gasket between the top face of plate 30 and the underside of lid 24, or between shoulder 36 and the edges 34 of manifold plate 30, to create a fluid-tight contact between the lid 24 and manifold plate 30 and to force fluid to flow through microchannels 28, and thus the inlet paths to the microchannels would be separated from the outlet paths from

the microchannels. Such O-rings and gaskets were well-known long before August 2007. In fact, the Danger Den-RBX is a good example of a prior art device having a gasket between the housing and the plate to separate the inlet paths to the microchannels from the outlet paths from the microchannels. Such a modification of the *Bhatti* device would be commonsense, particularly given *Bhatti's* teaching that "[a]ppropriate gaskets are sandwiched between the mating parts." *Bhatti*, ¶[0019]. A skilled artisan would have been motivated to make the modification to minimize leakage or fluid bypass issues, and would have reasonably expected success in doing so because of the simplicity of the modification and the commonsense value of providing seals between the mating parts of a fluidic device.

116. As further discussed in Exhibit B, Chart II, claims 15, 19, and 20 are rendered obvious by *Bhatti*. First, to the extent CoolIT may argue that *Bhatti* does not disclose the "seal" between the housing and the plate as recited in claim 12 (although I disagree with such an argument), it would have been obvious to one skilled in the art in August 2007 to provide an O-ring or another gasket between the top face of plate 30 and the underside of lid 24, or between shoulder 36 and the edges 34 of manifold plate 30, for all the reasons in the paragraph above. Second, it would have been obvious to one skilled in the art in August 2007 to modify *Bhatti's* manifold plate to have a single inlet channel and two outlet channels adjacent the microchannel ends, i.e., to have a single split-flow instead of multiple split- flows throughout the length of the channels, as discussed in Exhibit B, Chart II. A person skilled in the art would have been motivated to modify *Bhatti* to have a single split-flow to simplify the device and reduce manufacturing costs and complexities. Such single split-flow (i.e., single inlet and two outlets) was already well-known by August 2007. *See Kandlikar, Antarctica, Bonde, Danger Den-RBX, Hamilton,* etc. Therefore, a person skilled in the art would have reasonably expected success in making such a modification to the *Bhatti* device.

CONTAINS INFORMATION THAT COOLIT HAS DESIGNATED HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY

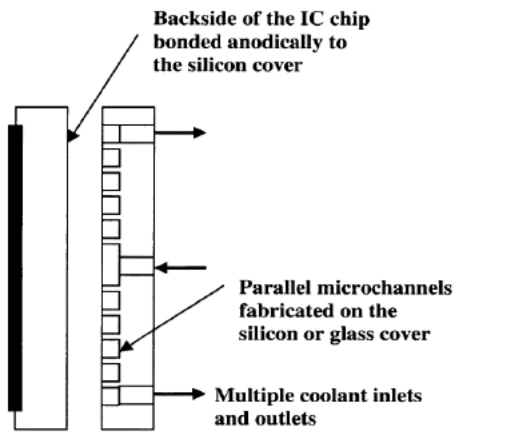


Figure 2 Schematic arrangement of an IC chip cooled with microchannels fabricated on a silicon or glass cover bonded anodically or glued to the backside of the chip (not to scale).

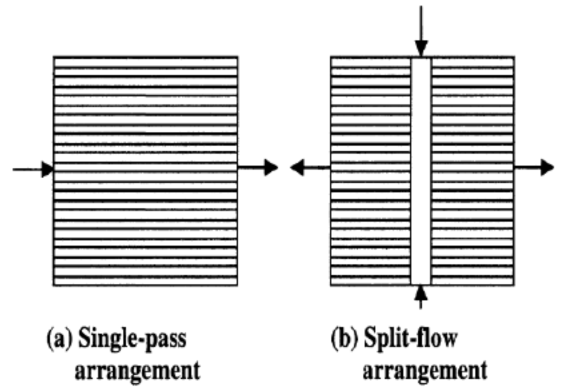


Figure 7 Schematic of single-pass and split flow arrangements showing fluid flow through microchannels (Kandlikar and Upadhye [6]).

Kandlikar, Figs. 2, 7 (showing single split-flow).

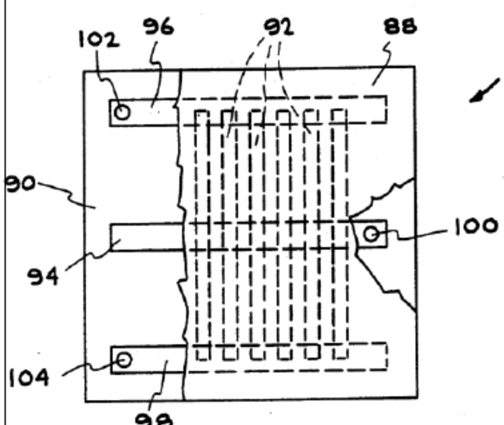


FIG. 6

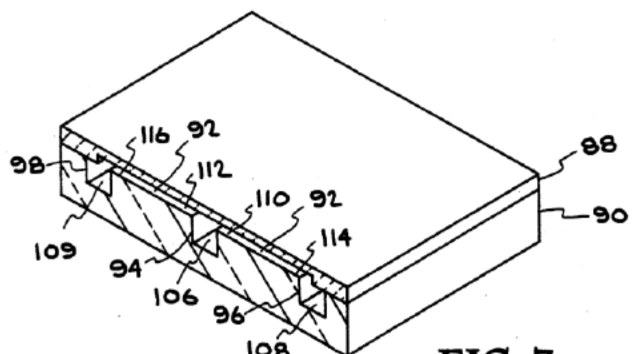


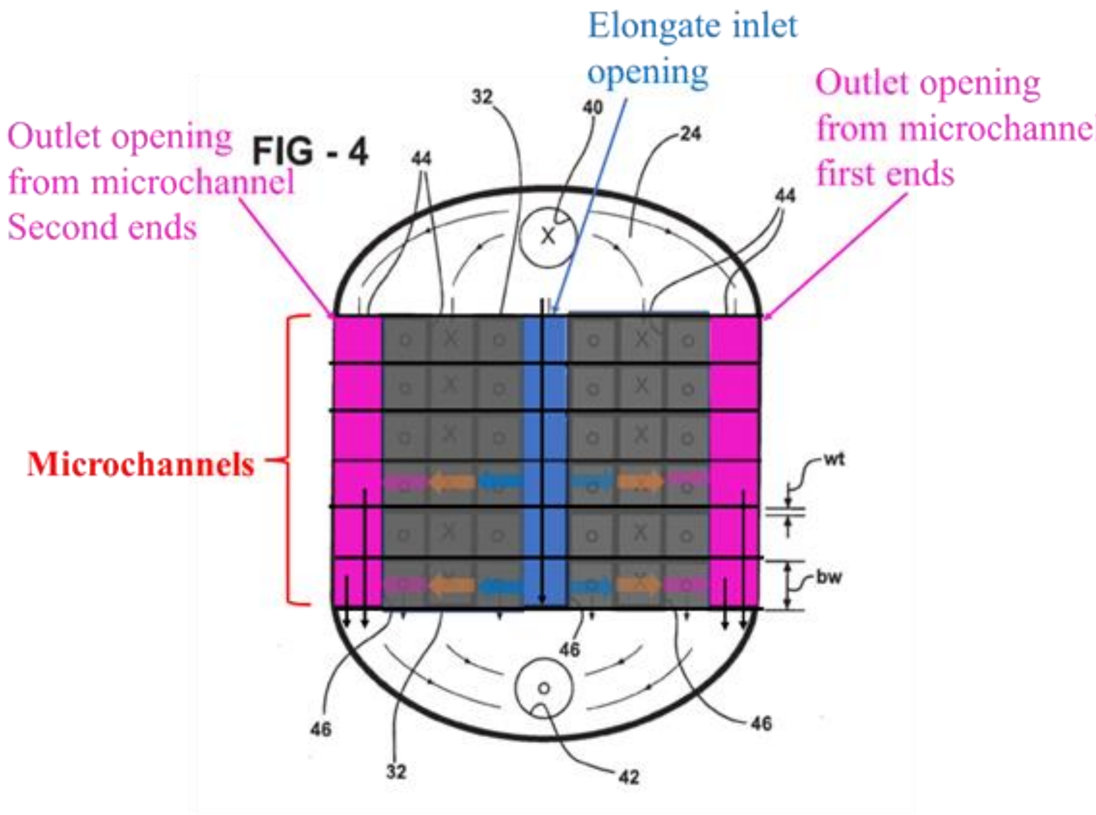
FIG. 7

Bonde, Figs. 6, 7 (same).

117. In IPR2020-00825 against CoolIT's '266 patent, CoolIT admitted that multiple split-flows have the function of "shorten[ing] the coolant flow path through the microchannels, and thereby lower[ing] pressure drop and flow resistance through the channels and enhanc[ing] heat transfer," and that elimination of multiple split-flows would eliminate that function and related performance advantages. CoolIT '266 POR at 52, 74; *id.* at 53, 54, 69, 75. CoolIT's omission of the multiple inlets and outlets in *Bhatti*, along with omission of their function — reducing flow length and pressure drop — was an obvious modification that an artisan would have implemented to reduce manufacturing cost and

complexities. In particular, by August 2007, technology for making high-aspect ratio microchannels in metal was available, so a skilled artisan would have been motivated to simplify the manifold architecture because multiple interleaved inlets and outlets in the manifold (as shown in *Bhatti*) would not have been needed for optimum thermal performance in a system with high-aspect ratio microchannels. That is, a person skilled in the art would have been motivated to simplify *Bhatti* to have a single inlet and two outlets because the multiple inlets and outlets architecture would not have been needed for optimal thermal performance if *Bhatti* was modified to include high-aspect ratio microchannels, which were common by August 2007. Such simplification of a prior art device, i.e., modification of *Bhatti* to have single split-flow instead of multiple split-flows, is not an invention. In fact, a skilled artisan in August 2007 would have known and understood that figuring out the number of inlets and outlets required in a microchannels-based heat exchanger is simply a matter of routine engineering and design choice, and is not innovation. This design choice is informed by the availability of technology for manufacturing high-aspect ratio microchannels in August 2007 and the disclosure of single split-flow in prior art publications and commercially available liquid cooling products. *See* discussion related to *Kang*, below, which is incorporated herein by reference.

118. In the modified *Bhatti* device, cooling fluid will enter the microchannels through the single inlet channel, split into two sub-flows and proceed outwardly towards the outlet channels/openings at the opposite ends of the microchannels, as shown below. The sub-flow of fluid directed towards the first end will exit the microchannels through the first outlet opening. The sub-flow directed towards the second end will exit the microchannels through the second outlet opening.



Bhatti, Fig. 4 (modified to show single split-flow).

F. *KANG* RENDERS OBVIOUS THE ASSERTED CLAIMS OF THE '284 PATENT

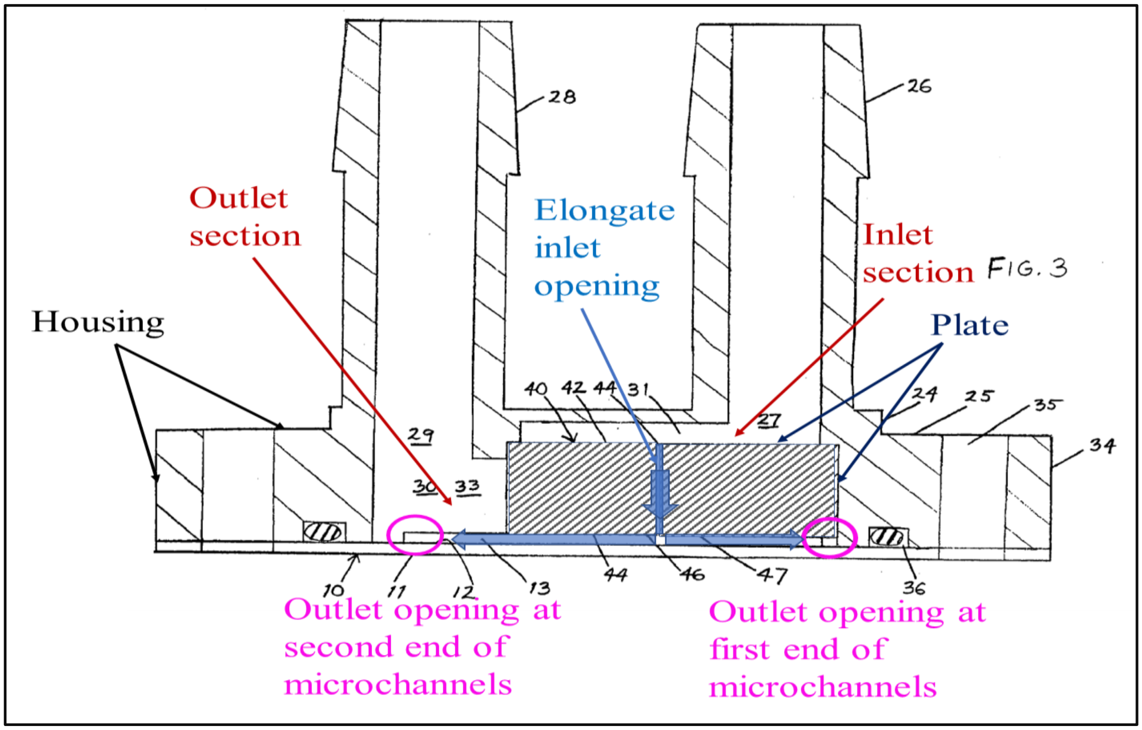
119. Chart III in Exhibit B demonstrates how each and every limitation of the asserted claims of the '284 patent are rendered obvious by *Kang* modified to have a single split-flow. While having a single inlet and two outlets (instead of an alternating series of inlets and outlets as shown in *Kang*) may increase flow resistance and pressure drop because of increased flow length through the microchannels, a person skilled in the art in August 2007 would have recognized that doing so would still have been reasonable for microchannels of smaller length, and/or if pressure drop could have been minimized using microchannels of larger hydraulic diameters, and/or if pressure drop could be compensated using a higher capacity pump. Modification of *Kang* to have a single inlet channel 47 and two outlets at respective ends of the microchannels would have been an obvious and routine simplification of the *Kang* device that a skilled artisan would have

been motivated to make to reduce manufacturing complexities and costs associated with having multiple inlets and outlets as shown in *Kang.* In particular, by August 2007, technology for making high-aspect ratio microchannels in metal was available, so a skilled artisan would have been motivated to simplify the manifold architecture because multiple interleaved inlets and outlets in the manifold (as shown in *Kang*) are not needed for optimum thermal performance in a system with high-aspect ratio microchannels. Therefore, if any enhancement of thermal performance was necessitated by the simplification of the manifold, *Kang's* microchannels would easily have been modified to high-aspect ratio microchannels. That is, a person skilled in the art would have been motivated to simplify *Kang* to have a single inlet and two outlets because the multiple inlets and outlets architecture would not have been needed for optimal thermal performance if *Kang* was modified to include high-aspect ratio microchannels, which were common by August 2007. Such simplification of a prior art device, i.e., modification of *Kang* to have single split-flow instead of multiple split-flows, is not an invention.

120. In fact, the choice of how to split the flow through microchannels to minimize pressure drop (e.g., to have two flow sections as in *Antarctica* and *Danger Den-RBX*, or multiple as in *Kang* and *Bhatti*) is simply a matter of design choice, not a matter of invention. Thus, the use of a single inlet and two outlets in the '284 patent, as opposed to multiple inlets and outlets as in *Kang*, is not a novel design element. In fact, the claimed arrangement of the '284 patent is a simplified version of the *Kang* device. Such split-flow arrangement having a single inlet and only two outlets at the respective ends of the microchannels was well-known in the industry by August 2007. *See, e.g.*, *Kandlikar,* Figs. 2, 7; *Bonde*, Figs. 6 and 7 (showing a split-flow arrangement having a single inlet 106 and two outlets 108, 109 at the ends of the microchannels), 7:7-43.

121. The figure below illustrates that the single-pass arrangement claimed in the '284 patent is an obvious and routine modification of the split-flow arrangement in *Kang* in order to achieve a simplified design that would be easier and less costly to manufacture. A skilled artisan in August 2007 would have known and understood that figuring out the number of inlets and outlets required in a microchannels-based heat exchanger is simply a matter of

routine engineering and design choice, and is not innovation. This design choice is informed by the availability of technology for manufacturing high-aspect ratio microchannels in August 2007 and the disclosure of single split-flow in prior art publications and commercially available liquid cooling products.



Id. at Fig. 3 (modified to have a single elongate inlet opening and two outlet openings at the microchannel ends; annotations added).

G. *HAMILTON* ANTICIPATES OR RENDERS OBVIOUS THE ASSERTED CLAIMS OF THE '284 PATENT

122. The claim chart IV in Exhibit B illustrates how the *Hamilton* correlates with the limitations in the asserted claims of the '284 patent. In my opinion, the *Hamilton* discloses each and every limitation of the asserted claims, and thus anticipates the asserted claims of the '284 patent.

123. To the extent CoolIT argues that *Hamilton* does not explicitly recite a "seal" in the embodiment shown in Figures 9-12, a person skilled in the art considering *Hamilton* would have readily envisaged that seals 58, 60 (shown in the Figure 8 embodiment)

would have been applied to the embodiment shown in Figures 9-12. That is, a person skilled in the art would have readily known from Figure 8 of *Hamilton* that seals 58, 60 would also have been used (even though *Hamilton* does not explicitly disclose it) with the embodiment in Figures 9-12 to seal the ducts 92, 94, 96 in housing 56' to the ports 86, 88, 90 in plate 24'. In other word, combining the seals 58, 60 with the embodiment shown in Figures 9-12 would be immediately apparent to one of ordinary skill in the art.

124. Seals 58, 60 would necessarily extend between housing 56' and plate 24'. Seals 58, 60 provide fluid-tight contact between the housing 56' and the plate 24', thus preventing leakage or fluid short-circuit between the inlet and outlet openings of the plate through gaps between the housing and the plate. By forcing fluid to flow through the microchannels, seals 58, 60 would separate the inlet flow path to each of the microchannels 68' from the outlet flow path from each of the microchannel first ends.

125. At a minimum, seal(s) between housing 56' and plate 24' would have been obvious to a person skilled in the art in August 2007 to separate the inlet flow paths from the outlet flow paths. A person skilled in the art would have been motivated to provide seals (such as seals 58, 60 discussed in *Hamilton*) to provide fluid-tight contact between the housing 56' and the plate 24', and thus prevent leakage or short-circuit between the inlet and the outlet openings of the plate through gaps between the housing and the plate. Moreover, a person skilled in the art would have reasonably expected success in modifying *Hamilton* with seal(s) between housing 56' and plate 24' because of the simplicity of the modification, *Hamilton*'s explicit disclosure of seals 58, 60 in the embodiment shown in Figure 8, and the commonsense value of providing seals between the mating parts of a fluidic device.

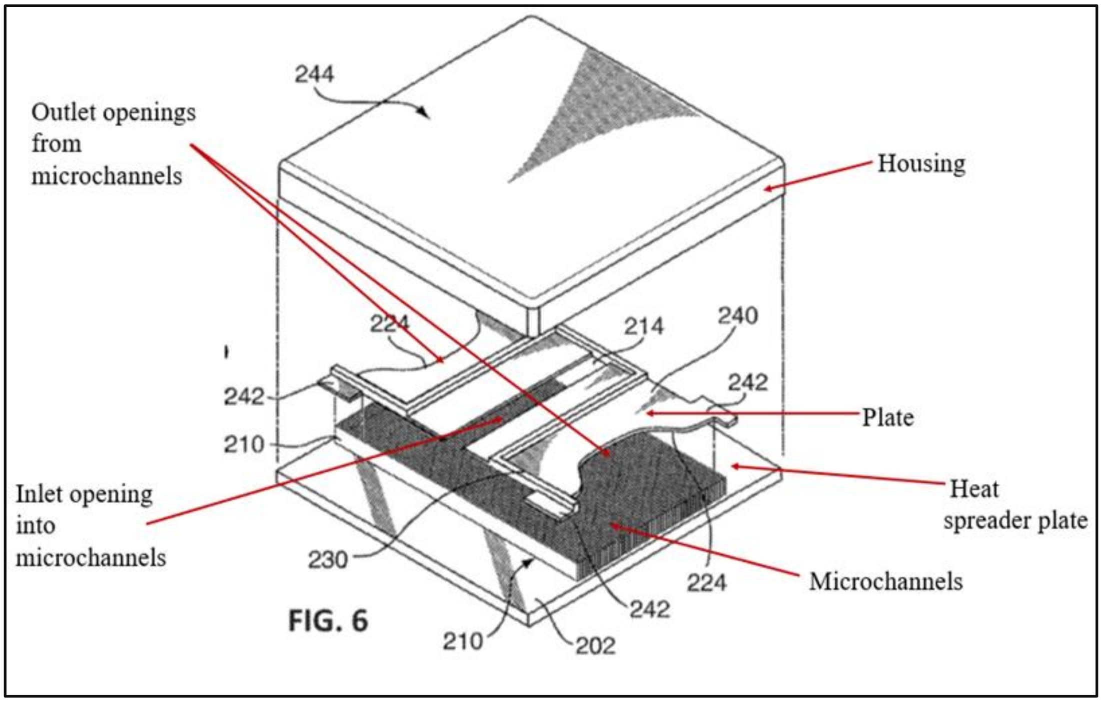
X. THE ASSERTED CLAIMS OF THE '266 PATENT ARE INVALID

A. BACKGROUND TECHNOLOGY OF THE '266 PATENT

126. The '266 patent describes three specific fluid heat exchanger embodiments. First, the fluid heat exchanger 100 shown in, for example, Figures 2 to 4. Second, the fluid heat exchanger 320 shown in, for example, Figures 7 and 11. And, third, the fluid heat exchanger 320′ shown in, for example, Figures 14 and 14A.

127. These three separate embodiments share common features. Each of the heat exchangers 100, 320 and 320′ includes a heat spreader (i.e., a cold plate), which accepts thermal energy from a heat source. '266 patent, 8:13-48, 11:47-12:2, 12:27-35, 16:60-17:8, Figs. 2-6, 7, 13, 13A, 14, 14A. Extending from the heat spreader are a plurality of juxtaposed fins defining a corresponding plurality of microchannels. *Id.* Further, each of the heat exchangers 100, 320 and 320′ includes a rigid plate (e.g., plate 240 shown in Figures 5 and 6 (annotated below)), or a compliant insert 334 shown in Figure 11 (also annotated below). *Id.* at 12:36-42, 14:60-15:30. The rigid plate or compliant insert is positioned within the heat exchanger so as to close off the tops of the microchannels, thereby forming an enclosed passage for fluid flow. *Id*. Because the asserted claims 13 and 15 of the '266 patent are directed to a "fluid heat exchanger" and specifically recite a "plate" (and not a compliant insert or manifold), these claims are directed to fluid heat exchanger 100. Therefore, my remaining discussion of the '266 patent focuses solely on the disclosure of fluid heat exchanger 100 in the '266 patent.

128. In the fluid heat exchanger 100, a seal 130/230 is provided to separate the fluid inlet passage 104 from the fluid outlet passage 106. *Id.* at 6:64-67. The seal forces fluid to flow through the microchannels instead of short-circuiting the inlet and outlet passage by flow through gaps between plate 240 and housing 109/cap 244. *See id.*



Id. at Fig. 6 (annotations added).

129. The plate 240 has cut-outs that form inlet and outlet/exhaust openings. *See, e.g., id.* at Figs. 2 and 6. For example, the plate positioned on the top of the microchannel walls in the embodiment shown in Figures 2-4 has an elongate opening 114. *Id.* at 9:35-10:33. The opening 114 extends over the microchannels 103, such that "fluid may flow through opening 114 down into the channels." *Id.* at 9:46-61. As shown in Figures 2, 5 and 6 of the '266 patent, the inlet opening in the plate runs transverse to the length of the microchannels and are aligned approximately over the center of the microchannels. *Id*. at 11:19-46. The pair of outlets through which working fluid exits the microchannels are illustrated in Figures 2, 5 and of the '266 patent as two contoured openings/cut-outs in the plate (i.e., outlets 124).

130. Positioning the opening at the midway creates a split-flow arrangement. *Id.* at 11:34-46. Specifically, after the working fluid enters the microchannels, the flow splits into two sub-flows each of which proceeds outwardly towards respective outlets at the ends of the microchannels. *Id.* Split-flow arrangements reduce fluid pressure drop through

microchannels. *Id*. at 11:41-46. These flow arrangements were known by those skilled in the art well before August 2007.

131. I have not analyzed whether claims 13 and 15 of the '266 patent are supported by the 2007 provisional or the '330 patent, or whether those claims are entitled to the priority dates of the earlier applications. I have been advised to use the August 9, 2007 date as the effective filing date for the purpose of my analysis of claims 13 and 15 of the '266 patent and assume that the timeframe for the alleged invention in those claims is on or around August 9, 2007.

B. SUMMARY OF PRIOR ART THAT INVALIDATES THE '266 PATENT

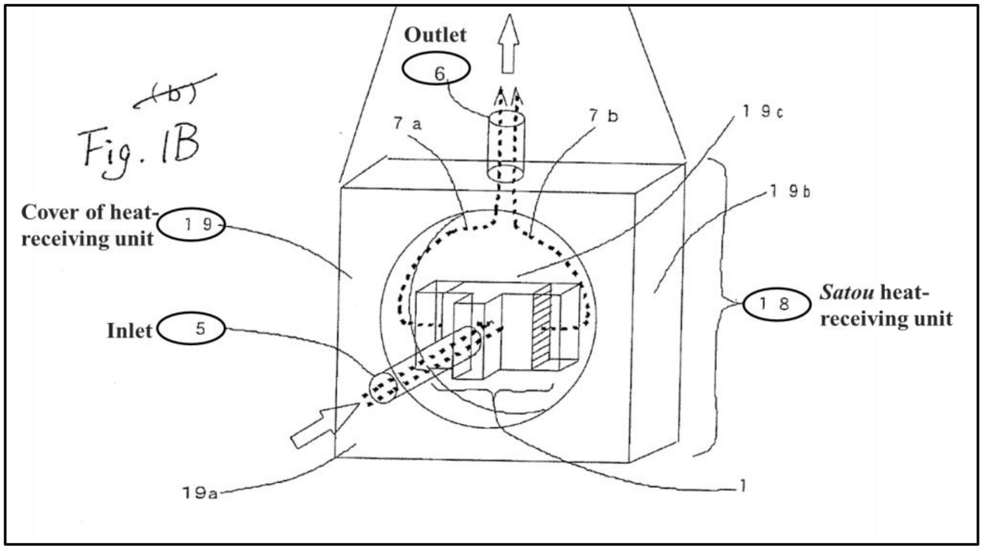
132. I am incorporating by reference here by discussion of *Antarctica* from Sections VIII and IX. Below is a discussion of the *Satou* reference.

<u>Satou</u>

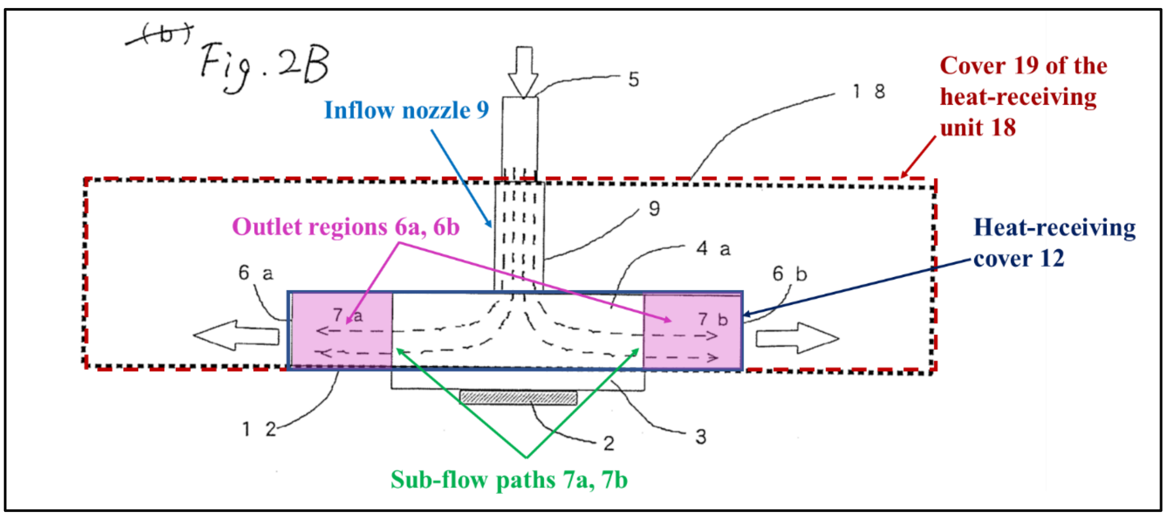
133. *Satou* was filed on November 19, 2006 and published on June 7, 2007. Therefore, *Satou* is prior art to the asserted claims 13 and 15 of the '266 patent.

134. *Satou* teaches a fluid heat exchanger (heat-receiving unit 18) for cooling an electronic device. *Satou* at ¶¶[000l], [0028], Figs. 1A, lB. Heat-receiving unit 18 is enclosed in a unit cover 19. *Id.* at ¶¶[0028], Fig. 1B. The *Satou* heat-receiving unit 18 includes a cold plate (heat-receiving section 1) having fins 4a thereon, which create a plurality of microchannels between themselves. *Satou* at ¶¶[0029], [0030], [0032], and Fig. 2A. A heat-receiving cover 12 overlies and contacts the top of the fins 4a, thus closing off the microchannels. *See id.* at ¶[0030], Figs. 2A, 2B. Inlet 5 of the *Satou* heat-receiving unit delivers fluid through the inflow nozzle 9 (provided inside cover 19 and on heat-receiving cover 12) to the plurality of microchannels at a position between the first ends and second ends of the microchannels. *Satou* at ¶¶[0029], [0030], [0032], Figs. 2A, 2B. The cooling fluid entering the microchannels split into sub-flows 7a and 7b, wherein one sub-flow proceeds towards the first ends of the microchannels and the other sub-flow proceeds towards the second ends of the microchannels. *See id.* Cooling fluid exits the

microchannels at outlet regions 6a and 6b provided at the microchannel ends, recombines within cover 19, and then flow out of the heat-receiving unit 18 through outlet 6. *See id.*; *see also* FIG. 1B.



Satou, Fig. 1B (annotations added).



Id. at Fig. 2B (annotations added).

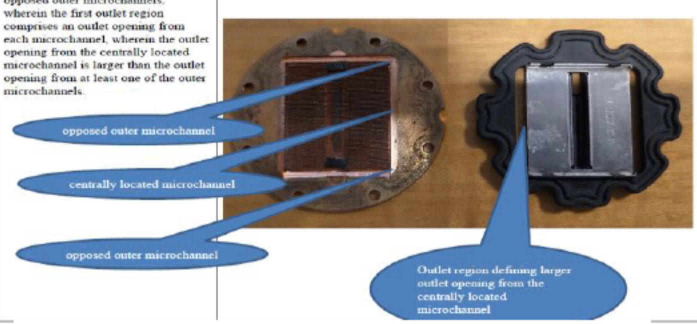
C. THE *ANTARCTICA* ANTICIPATES CLAIMS 13 AND 15, OR RENDERS THEM OBVIOUS ALONE OR IN VIEW OF *SATOU*

135. As discussed in Exhibit C, the *Antarctica* water block has each and every element of the claims 13 and 15. Therefore, *Antarctica* anticipates claims 13 and 15.

136. To the extent CoolIT argues the *Antarctica* does not have a single "fluid outlet passage," modification of the *Antarctica* waterblock to have a single "fluid outlet passage" — where cooling fluid collects before exiting the waterblock — would have been obvious in view of the benefits discussed in Exhibit C. In particular, a skilled artisan would have been motivated to modify the *Antarctica* to have a single "fluid outlet passage," as shown in the *Antarctica* user guide, to make installation of the system easier for the user and to minimize the risk of fluid leakage. *Satou* additionally discusses a single "fluid outlet passage" (portion of the unit cover 19) where cooling fluid from the microchannel first and second ends collect prior to exiting the fluid heat exchanger (heat-receiving unit 18) via a single outlet 6. *See* Exhibit C.

137. With respect to claim 15 of the '266 patent, CoolIT's infringement contentions against Asetek's products interpret the region adjoining the outlets from the microchannels, where fluid flows into after exiting the microchannels, as the "outlet opening." In fact, CoolIT appears to be interpreting "outlet flow path" (recited in the '284 patent claims) and the "outlet opening" in the '266 patent synonymously and interchangeable. I do not agree with that because it is my understanding that different claim terms must have different meanings. Regardless, consistent with CoolIT's interpretation of "outlet opening" (although I do not agree with it), I have shown below and in Exhibit C that the "outlet opening" from a central microchannel in the *Antarctica* waterblock is larger than the "outlet opening" from an outer microchannel, as shown below.

'266 Patent Claim	Evidence of Infringement
15. The fluid heat exchanger according to claim 12, wherein the plurality of microchannels comprises at least two opposed outer microchannels and a centrally located microchannel positioned between the opposed outer microchannels, wherein the first outlet region comprises an outlet opening from each microchannel, wherein the outlet opening from the centrally located microchannel is larger than the outlet opening from at least one of the outer microchannels.	As shown below, the H55 has at least two opposed outer microchannels and a centrally located microchannel positioned between the opposed outer microchannels. Each microchannel has an outlet opening wherein the outlet opening from the centrally lcoated microchannel is larger than the outlet opening from at least one of the outer microchannels.



CoolIT's infringement contentions against representative Gen 4 Asetek product

enhance the overall pumping and thermal performance of the heat exchange system. Therefore, CoolIT cannot establish nexus between the merits of its asserted claims and the alleged secondary considerations.

146. As mentioned above, if CoolIT later presents evidence linking its alleged commercial success of the ECO-II (or other commercial products) to split flow, I reserve the right to present a supplemental report addressing such evidence.

XII. NOTICE AND SUPPLEMENTATION

147. I understand that discovery is ongoing in this case. Therefore, I reserve the right to supplement my opinions after I have had the opportunity to review deposition testimony or in light of additional documents that may be brought to my attention.

148. For the purposes of this Report, I have reviewed materials and testimony that I believe are appropriate considering the evidence available at this time. I understand that I will have the right to supplement or amend this Report in the event additional evidence or information pertinent to my opinions becomes available, and I plan to do so. I may also provide rebuttal to any opinions of other fact and expert witnesses, should I be requested to do so.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 3rd day of November 2021.

David B. Tuckerman

David B. Tuckerman, Ph.D.